

PHYSICS

1) An expression for a dimensionless quantity P is given by $P = \frac{\alpha}{\beta} \log_e \left(\frac{kt}{\beta x} \right)$; where α and β are constants, x is distance; k is Boltzmann constant and t is the temperature. Then the dimensions of α will be :-

- (1) $[M^0 L^{-1} T^0]$
- (2) $[ML^0 T^{-2}]$
- (3) $[MLT^{-2}]$
- (4) $[ML^2 T^{-2}]$

2) A toy plane is flying horizontally at 10 m/s at height 80 m above the ground towards a man on the ground as shown. When plane is 60m away horizontally from man, a ball is dropped by the plane. Find speed of man (assumed uniform) so that he is able to catch the ball just before it strikes the



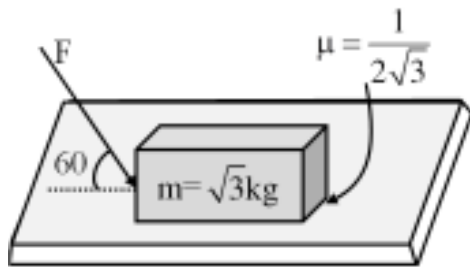
ground ($g = 10 / s^2$) :-

- (1) 10 m/s
- (2) 15 m/s
- (3) 5 m/s
- (4) 7.5 m/s

3) A bullet is fired on a fixed target. It penetrates inside the target through distance $d = 4$ cm and then stops, mass of bullet is $m = 1$ kg and of target is $M = 4$ kg. Now identical bullet moving with same velocity is fired on identical target which is placed at rest on frictionless horizontal surface. Then find the distance (in mm) to which the bullet will penetrate inside the target ?

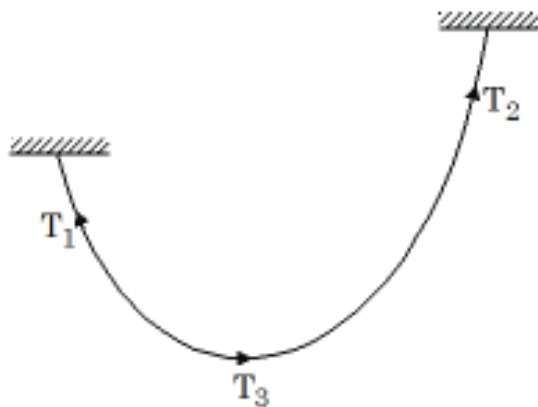
- (1) 36 mm
- (2) 42 mm
- (3) 32 mm
- (4) 24 mm

4) In the given figure, find the maximum value of force 'F' for which the block does not slide)



- (1) 10 N
- (2) 20 N
- (3) 30 N
- (4) 40 N

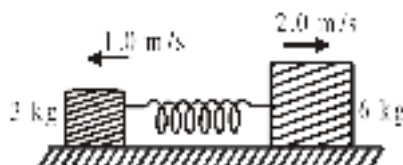
5) A string of mass m (can be non uniform as well) is suspended through two points which are not in same horizontal level. Tension in the string at the end points are T_1 and T_2 and at the lowest point is T_3 . Mass of string in terms of T_1 , T_2 and T_3 can be represented as {uniform gravity 'g' exists



downwards)

- (1) $\frac{\sqrt{T_1^2 - T_3^2} + \sqrt{T_2^2 - T_3^2}}{g}$
- (2) $\frac{(T_1 + T_2 - 2T_3)}{g}$
- (3) $\frac{\sqrt{T_1^2 + T_2^2}}{g}$
- (4) $\frac{\sqrt{T_1^2 + T_3^2} + \sqrt{T_2^2 + T_3^2}}{g}$

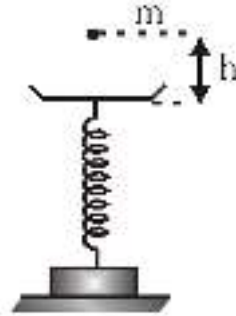
6) Two blocks of mass 3 kg and 6 kg respectively are placed on a smooth horizontal surface. They are connected by a light spring of force constant $k = 200$ N/m. Initially the spring is unstretched. The indicated velocities are imparted to the blocks. The maximum extension of the spring will be :-



- (1) 30 cm

- (2) 25 cm
- (3) 20 cm
- (4) 15 cm

7) A ball of mass m is dropped from a height h on a platform fixed at the top of a vertical spring. The



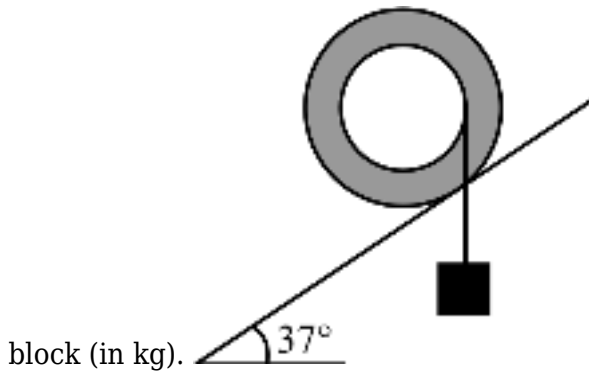
platform is displaced by a distance x . The spring constant is :

- (1) $\frac{2mg}{x}$
- (2) $\frac{2mgh}{x^2}$
- (3) $\frac{2mg(h+x)}{x^2}$
- (4) $\frac{2mg(h+x)}{h^2}$

8) The PE of a 2 kg particle, free to move along x-axis is given by $V(x) = \left(\frac{x^3}{3} - \frac{x^2}{2} \right)$ J. The total mechanical energy of the particle is 4 J. Maximum speed (in ms^{-1}) is :-

- (1) $\frac{1}{\sqrt{2}}$
- (2) $\sqrt{2}$
- (3) $\frac{3}{\sqrt{2}}$
- (4) $\frac{5}{\sqrt{6}}$

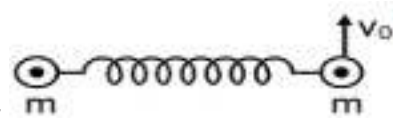
9) A 3.0 kg bobbin consists of a central cylinder of radius 6.0 cm and two end plates each of radius 7.0 cm. It is placed on a slotted incline, where friction is sufficient to prevent sliding. A block is suspended from a cord wound around the bobbin and passing through the slot under the incline. If the bobbin is in static equilibrium, and the angle of tilt of the incline is 37° . What is the mass of



block (in kg).

- (1) 21
- (2) 7
- (3) 9
- (4) 11

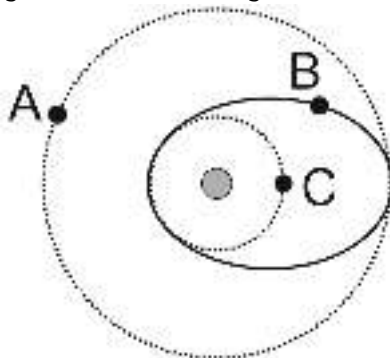
10) Two particles each of mass m , rest on a smooth horizontal floor and are connected by an ideal non deformed spring of natural length ℓ and spring constant k . If one of the particle is given velocity v_0 perpendicular to the line joining the particles as shown in the figure, maximum elongation x of the



spring in process of motion assuming $x \ll \ell$ will be :-

- (1) $\frac{mV_0^2}{K\ell}$
- (2) $\frac{2mV_0^2}{K\ell}$
- (3) $\frac{mV_0^2}{2K\ell}$
- (4) $\frac{mV_0^2}{3K\ell}$

11) Three equal mass satellites A, B, and C are in coplanar orbits around a planet as shown in the figure. The magnitudes of the angular momenta of the satellites as measured about the planet are

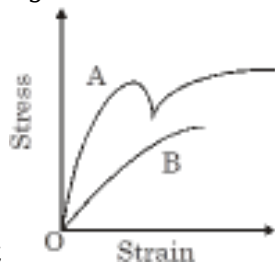


L_A , L_B and L_C .

- (1) $L_A > L_B > L_C$
- (2) $L_C > L_B > L_A$
- (3) $L_B > L_C > L_A$

(4) $L_B > L_A > L_C$

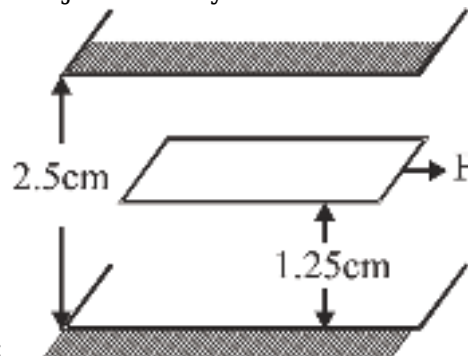
12) The diagram show stress versus strain curve for the materials A and B . From the curves we



infer that

- (1) A is brittle but B is ductile
- (2) A is ductile and B is brittle
- (3) both A and B are ductile
- (4) both A and B are brittle

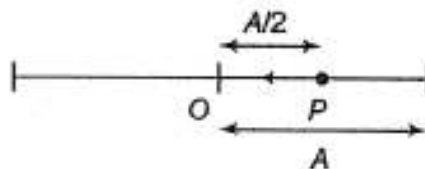
13) A space 2.5 cm wide between two large plane surfaces is filled with oil. Force required to drag a very thin plate of area 0.5 m^2 just midway the surfaces at a speed of 0.5 m/sec is 1 N . The coefficient



of viscosity in kg-s/m^2 is :

- (1) 5×10^{-2}
- (2) 2.5×10^{-2}
- (3) 1×10^{-2}
- (4) 7.5×10^{-2}

14) A particle starts from a point P at a distance of $\frac{A}{2}$ from the mean position O and travels towards left as shown in the figure. If the time period of SHM, executed about O is T and amplitude A then

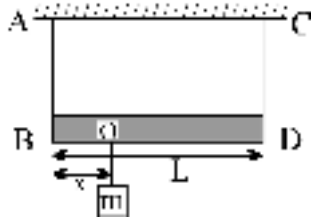


the equation of the motion of particle is

- (1) $x = A \sin \left(\frac{2\pi}{T}t + \frac{\pi}{6} \right)$
- (2) $x = A \sin \left(\frac{2\pi}{T}t + \frac{5\pi}{6} \right)$
- (3) $x = A \cos \left(\frac{2\pi}{T}t + \frac{\pi}{6} \right)$

(4) $x = A \cos \left(\frac{2\pi}{T}t + \frac{\pi}{3} \right)$

15) A massless rod BD is suspended by two identical strings AB and CD of equal length. A block of mass m is suspended from point O such that BO is equal to 'x'. Further, it is observed that the frequency of 1st harmonic (fundamental frequency) in AB is equal to 2nd harmonic frequency in CD.



Then, length of BO is

- (1) $\frac{L}{5}$
- (2) $\frac{L}{4}$
- (3) $\frac{4L}{5}$
- (4) $\frac{3L}{4}$

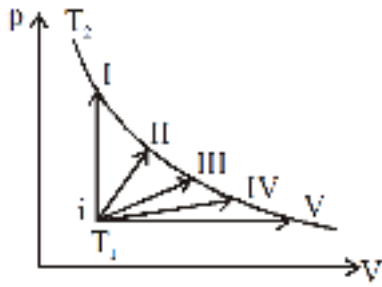
16) An open organ pipe of length 94 cm and radius 5 cm resonates with a tuning fork of frequency 160 Hz and 320 Hz. If these correspond to fundamental mode and first overtone respectively, what is the speed of sound (in m/s)?

- (1) 320
- (2) 310.4
- (3) 300.8
- (4) 339.2

17) In a room where temperature is 0°C, two objects A & B are kept. A is a black body at a temperature of 273°C and B is an object of emissivity 0.3 and temperature of 546°C. Both bodies have same area and mass. If specific heat capacity of A is half that of B, the ratio of initial rates of cooling of A and B will be :-

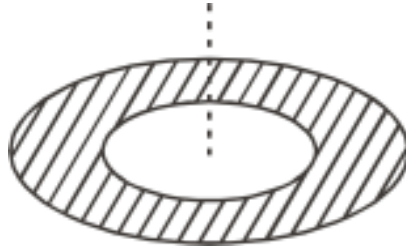
- (1) $\frac{5}{3}$
- (2) $\frac{3}{10}$
- (3) $\frac{5}{4}$
- (4) None

18) An ideal gas is to be taken reversibly from state i, at temperature T_1 , to any of the other states labeled, I, II, III, IV and V on the p-V diagram below. All are at the same temperature T_2 . Rank the five processes according to the change in entropy of the gas, least to greatest :



- (1) I, II, III, IV, V
- (2) V, IV, III, II, I
- (3) I, then II, III, IV, and V tied
- (4) I, II, III and IV tied, then V

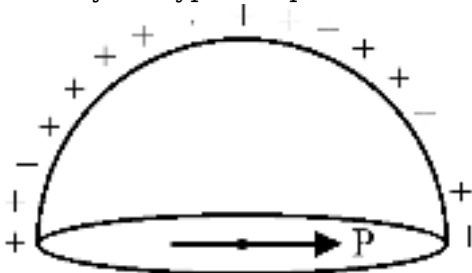
19) A thin disc of radius $b = 2a$ has a concentric hole of radius ' a ' in it (see figure). It carries uniform surface charge ' σ ' on it. If the electric field on its axis at height ' h ' ($h \ll a$) from its centre is given



as ' $C'h$ ' then value of ' C ' is :-

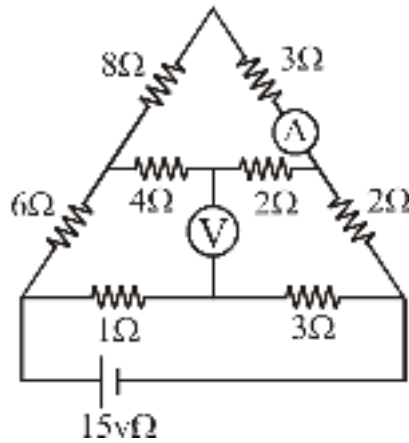
- (1) $\frac{\sigma}{4a\epsilon_0}$
- (2) $\frac{\sigma}{2a\epsilon_0}$
- (3) $\frac{\sigma}{8a\epsilon_0}$
- (4) $\frac{\sigma}{a\epsilon_0}$

20) A dipole is kept in circular plane of a uniformly charged hemispherical shell. Center of dipole coincide with center of hemispherical shell and dipole is restricted to move in given circular plane. Identify it's type of equilibrium if dipole is slightly rotate in this plane :-



- (1) Neutral
- (2) Unstable
- (3) Stable
- (4) Depends upon the direction of rotation

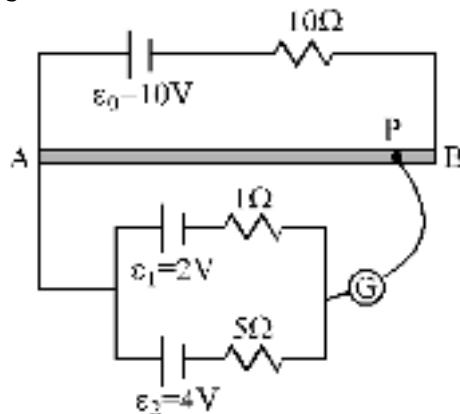
21) In the circuit shown, the reading of ammeter and voltmeter will be. (Voltmeter is ideal, but



ammeter has a resistance of 1Ω .)

- (1) $\frac{5}{12}\text{A}, \frac{25}{12}\text{V}$
- (2) $\frac{5}{6}\text{A}, \frac{85}{12}\text{V}$
- (3) $\frac{5}{12}\text{A}, \frac{85}{12}\text{V}$
- (4) $\frac{5}{6}\text{A}, \frac{25}{12}\text{V}$

22) A battery of emf $\epsilon_0 = 10\text{ V}$ is connected across a 1 m long uniform wire AB having resistance $10\Omega/\text{m}$. Two cells of emf $\epsilon_1 = 2\text{ V}$ and $\epsilon_2 = 4\text{ V}$ having internal resistances 1Ω and 5Ω respectively are connected as shown in the figure. If a galvanometer shows no deflection at the point P, find the

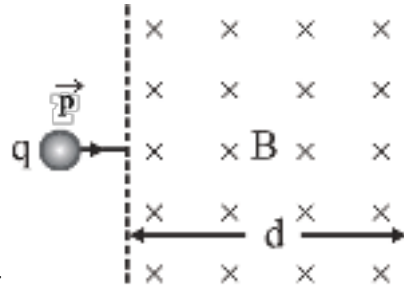


distance of point P from the point A :-

- (1) 46.6 cm
- (2) 51.5 cm
- (3) 25 cm
- (4) 65.6 cm

23) A particle with charge q , moving with a momentum p , enters a uniform magnetic field normally.

The magnetic field has magnitude B and is confined to a region of width d , where $d < \frac{p}{Bq}$, The



particle is deflected by an angle θ in crossing the field :-

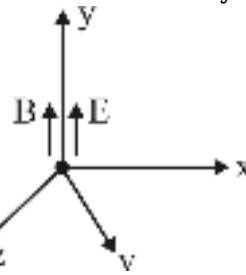
(1) $\sin \theta = \frac{Bqd}{p}$

(2) $\sin \theta = \frac{p}{Bqd}$

(3) $\sin \theta = \frac{Bp}{qd}$

(4) $\sin \theta = \frac{pd}{Bq}$

24) A positive charge particle having charge q and mass m has velocity $\vec{v} = v \left(\frac{\hat{i} + \hat{k}}{\sqrt{2}} \right)$ in the magnetic



field at the origin. Its speed as the function of y is :-

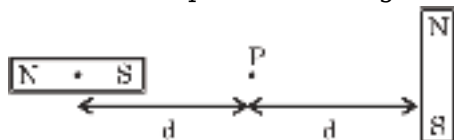
(1) $\sqrt{v^2 + \frac{qE}{2m}y}$

(2) $\sqrt{\left(\frac{B}{E}\right)^2 + v^2 + \frac{qE}{2m}y}$

(3) $\sqrt{v^2 + \frac{2qE}{m}y}$

(4) None of the above

25) Two short bar magnets of magnetic moment M each are placed as shown in diagram. The centre of both the dipoles lies along the same line as P . The magnetic field at P is given by ($K = \mu_0/4\pi$) :-



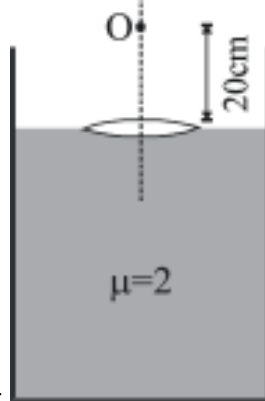
(1) $\frac{2KM}{d^3}$

(2) $\frac{KM\sqrt{13}}{d^3}$

(3) $\frac{KM\sqrt{5}}{d^3}$

(4) $\frac{KM\sqrt{2}}{d^3}$

26) A point object O is placed at a distance of 20 cm in front of a equi-convex lens ($\mu_g = 1.5$) of focal length 10 cm . The lens is placed on a liquid of refractive index 2 as shown. Image will be formed at



a distance h from lens. The value of h is :-

- (1) 5 cm
- (2) 10 cm
- (3) 20 cm
- (4) 40 cm

27) In Young's double slit experiment, if the widths of the slit are in the ratio 4:9, ratio of intensity of maxima to intensity of minima will be

- (1) 25:1
- (2) 9:4
- (3) 3:2
- (4) 81:16

28) An electron and proton are separated by a large distance and the electron approaches the proton with a kinetic energy of 2.4 eV. If the electron is captured by the proton to form a hydrogen atom in the ground state, the wavelength of the photon given off is (Assume $hc = 1240 \text{ eVnm}$) :

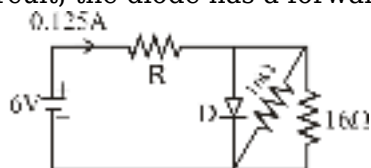
- (1) 0.775 nm
- (2) 7.75 nm
- (3) 75.5 nm
- (4) 77.5 nm

29) The radioactivity of a given sample of whisky due to tritium (half-life 12.3 years) was found to be only 3% of that measured in a recently purchased bottle marked "7 years old". The sample must have been prepared about :-

- (1) 220 years back
- (2) 300 years back
- (3) 400 years back

(4) 70 years back

30) In the given circuit, the diode has a forward resistance of $8\ \Omega$ and infinite backward resistance.



The value of R is :-

- (1) $44\ \Omega$
- (2) $48\ \Omega$
- (3) $16\ \Omega$
- (4) $8\ \Omega$

CHEMISTRY

1) Which of the following is least basic?

- (1) $(\text{CH}_3\text{CO})\ddot{\text{N}}\text{HC}_2\text{H}_5$
- (2) $(\text{C}_2\text{H}_5)_3\ddot{\text{N}}$
- (3) $(\text{CH}_3\text{CO})_2\ddot{\text{N}}\text{H}$
- (4) $(\text{C}_2\text{H}_5)_2\ddot{\text{N}}\text{H}$

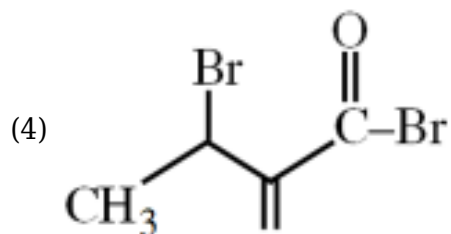
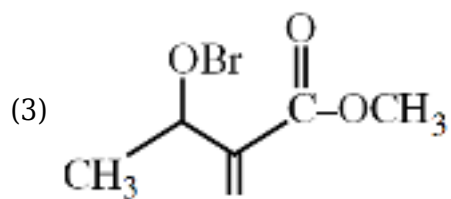
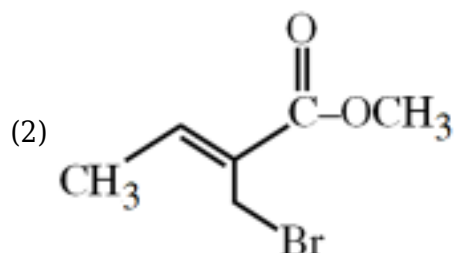
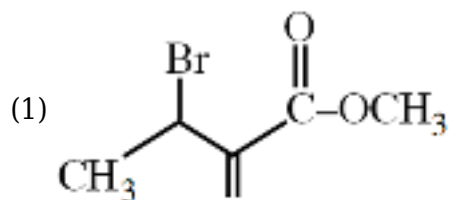
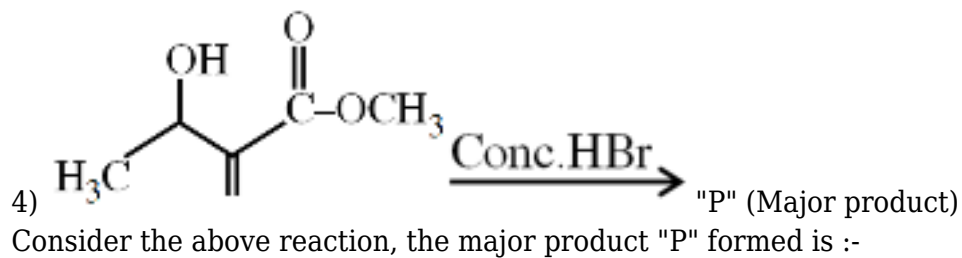
2) Which of the following molecules does not show stereo isomerism ?

- (1) 3,4-Dimethylhex-3-ene
- (2) 3-Methylhex-1-ene
- (3) 3-Ethylhex-3-ene
- (4) 4-Methylhex-1-ene

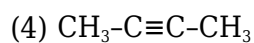
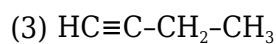
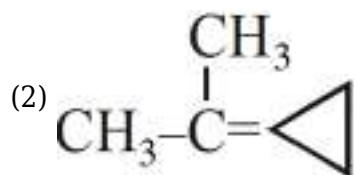
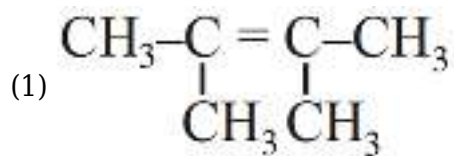
3) The correct pair(s) of the ambident nucleophiles is (are) :

- (A) AgCN/KCN
- (B) $\text{RCOOAg}/\text{RCOOK}$
- (C) $\text{AgNO}_2/\text{KNO}_2$
- (D) AgI/KI

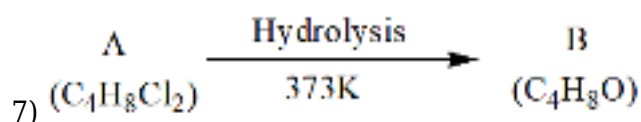
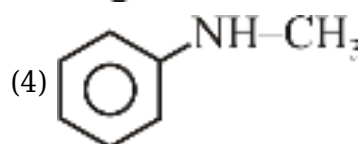
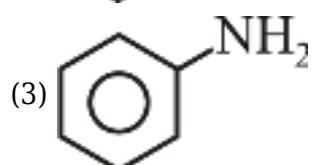
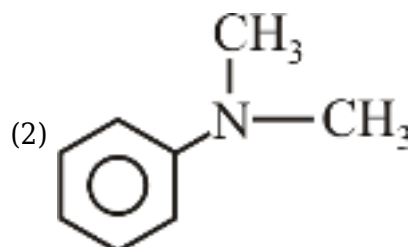
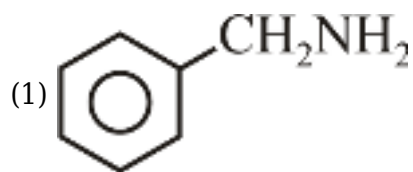
- (1) (B) and (C) only
- (2) (A) only
- (3) (A) and (C) only
- (4) (B) only



5) An unsaturated hydrocarbon X on ozonolysis gives A. Compound A when warmed with ammoniacal silver nitrate forms a bright silver mirror along the sides of the test tube. The unsaturated hydrocarbon X is :

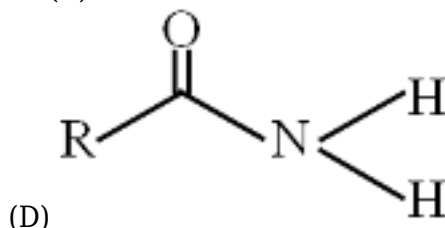
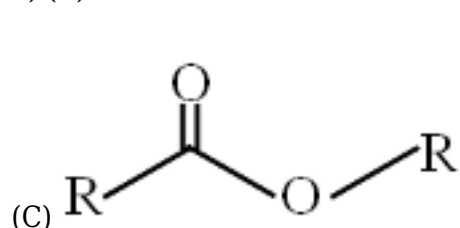
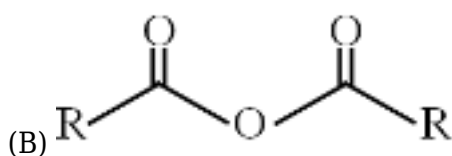
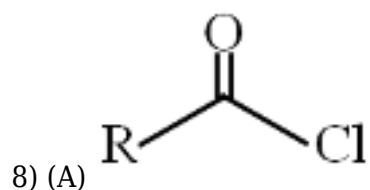


6) The diazonium salt of which of the following compounds will form a coloured dye on reaction with β -Naphthol in NaOH ?



B reacts with Hydroxyl amine but does not give Tollen's test. Identify A and B

- (1) 1,1-Dichlorobutane and 2-Butanone
- (2) 2,2-Dichlorobutane and Butanal
- (3) 1,1-Dichlorobutane and Butanal
- (4) 2,2-Dichlorobutane and Butan-2-one



The **correct** order of their reactivity towards hydrolysis at room temperature is :

- (1) (A) > (B) > (C) > (D)
- (2) (D) > (A) > (B) > (C)
- (3) (D) > (B) > (A) > (C)
- (4) (A) > (C) > (B) > (D)

9) Primary, secondary and tertiary amines can be separated using :-

- (1) Para-Toluene sulphonyl chloride
- (2) Chloroform and KOH
- (3) Benzene sulphonic acid
- (4) Acetyl amide

10) The secondary structure of protein is stabilised by:

- (1) Peptide bond
- (2) glycosidic bond
- (3) Hydrogen bonding
- (4) an der Waals forces

11) The Difference in wavelength of first and last line of lyman series in emission spectrum of He^+ would be :

- (1) $\frac{1}{12R_H}$
- (2) $\frac{12}{R_H}$
- (3) $\frac{1}{4R_H}$
- (4) $\frac{1}{3R_H}$

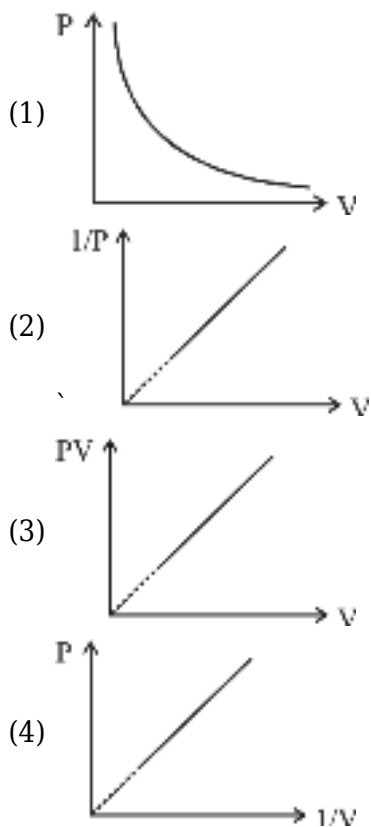
12) Calculate molality of one litre of solution containing 200 gm CaBr_2 . Given density of solution equal to 1.0 gm/ml (Atomic mass of Ca = 40, Br = 80)

- (1) 1m
- (2) 1.25 m
- (3) 0.8 m
- (4) 1.4 m

13) What should be the value of K_c for the reaction $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$, if the amount are $\text{SO}_3 = 48 \text{ g}$, $\text{SO}_2 = 12.8 \text{ g}$ and $\text{O}_2 = 9.6 \text{ g}$ at equilibrium and the volume of the container is one litre?

- (1) 64
- (2) 30
- (3) 42
- (4) 8.5

14) Which of the following curves does not represent Boyle's Law -

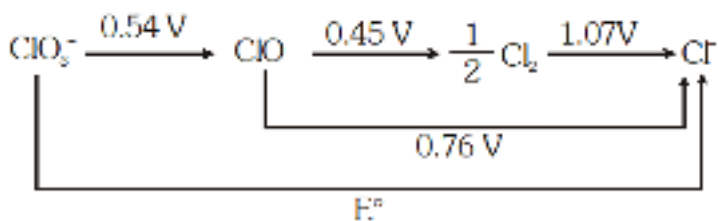


15)

For a reaction $2\text{NH}_3 \rightarrow \text{N}_2 + 3\text{H}_2$, it is observed that

$$-\frac{d[\text{NH}_3]}{dt} = K_1[\text{NH}_3]; +\frac{d[\text{N}_2]}{dt} = K_2[\text{NH}_3] \quad \text{and} \quad +\frac{d[\text{H}_2]}{dt} = K_3[\text{NH}_3].$$

- (1) $K_1 = K_2 = K_3$
- (2) $2K_1 = 3K_2 = 6K_3$
- (3) $3K_1 = 6K_2 = 2K_3$
- (4) $6K_1 = 3K_2 = 2K_3$



16)

The E° in the given figure is,

- (1) 0.5
- (2) 0.6
- (3) 0.7
- (4) 0.8

17) Two moles of an ideal gas ($C_{v,m} = \frac{5}{2}R$) was compressed adiabatically against constant pressure of

2 atm. which was initially at 350 K and 1 atm pressure. The work involve in the process is equal to

- (1) 250 R
- (2) 300 R
- (3) 400 R
- (4) 500 R

18) Copper metal crystallizes in FCC lattice. Edge length of unit cell is 362 pm. The radius of largest atom that can fit into the voids of copper lattice without disturbing it -

- (1) 53 pm
- (2) 45 pm
- (3) 93 pm
- (4) 60 pm

19) The number of moles of CH_3COONa added to 1 litre of 0.1M CH_3COOH solution to prepare a buffer solution of $\text{pH} = 4$ (K_a of $\text{CH}_3\text{COOH} = 2 \times 10^{-5}$) :

- (1) 0.01
- (2) 0.02
- (3) 0.03
- (4) 0.04

20) The vapour pressure of a solution of a non-volatile electrolyte B in a solvent A is 95% of the vapour pressure of the solvent at the same temperature. If the molecular weight of the solvent is 0.3 times the molecular weight of solute, the weight ratio of the solvent and solute are

- (1) 0.15
- (2) 5.7
- (3) 0.2
- (4) 4.0

21) Which of the following mentioned property is more for nitrogen as compared to the oxygen ?

- (1) Effective nuclear charge
- (2) Ionisation energy
- (3) Electron affinity
- (4) Electronegativity

22) The state of hybridisation of central atom in dimer form of both BH_3 and BeH_2 is

- (1) sp^2 , sp
- (2) sp^3 , sp^2
- (3) sp^3 , sp^3
- (4) sp^2 , sp^3

23) The ligand with which the homoleptic octahedral complex of Co^{3+} will be most stable is:

- (1) Ethylenediaminetetraacetato
- (2) Oxalato
- (3) Ethane-1,2-diamine
- (4) Ammonia

24) Which of the following conversion is **CORRECT** for indicated process ?

- (1) $\text{PbSO}_4 \xrightarrow{\Delta} \text{PbO} + \text{SO}_2 + 1/2 \text{O}_2$ (roasting)
- (2) $\text{PbSO}_4 + \text{PbS} \xrightarrow{\Delta} \text{Pb} + 2\text{SO}_2$ (self reduction)
- (3) $2\text{Na}[\text{Ag}(\text{CN})_2] + \text{Zn} \rightarrow \text{Na}_2[\text{Zn}(\text{CN})_4] + 2\text{Ag}$ (leaching)
- (4) $\text{CuSO}_4 (\text{aq.}) + 2\text{Ag} \rightarrow \text{Ag}_2\text{SO}_4 (\text{aq.}) + \text{Cu}$ (metal displacement method)

25)

Which of the following statement is INCORRECT ?

- (1) Ferric ions gives brown precipitate with NaOH solution, which is insoluble in excess of NaOH solution
- (2) Cu^{2+} ions gives brown ppt. with $\text{K}_4[\text{Fe}(\text{CN})_6]$ solution
- (3) Ferric ions gives brown colouration with $\text{K}_3[\text{Fe}(\text{CN})_6]$ solution
- (4) Ferrous ion gives blue ppt with $\text{K}_4[\text{Fe}(\text{CN})_6]$ solution

26)

Which of the following properties does not represent the diagonal relationship between them :-

- (1) Li_2O and MgO both do not combine with excess oxygen to form superoxide
- (2) LiCl and MgCl_2 are soluble in ethanol
- (3) Li^+ forms complex with co-ordination number of 4 while Mg^{2+} forms complex with co-ordination number of 6
- (4) LiCl and MgCl_2 both are deliquescent

27) In which of the following reaction all product are not soluble

- (1) $\text{Cr}^{3+} + \text{S}_2\text{O}_8^{2-} \xrightarrow{\text{aq. solution}}$
- (2) $\text{Mn}^{2+} + \text{S}_2\text{O}_8^{2-} \xrightarrow{\text{aq. solution}}$
- (3) $\text{I}^- + \text{S}_2\text{O}_8^{2-} \xrightarrow{\text{Fe}^{3+}}$
- (4) $\text{MnO}_4^{2-} \xrightarrow{\text{H}^+}$

28) The correct melting point order of 1st series of transition elements-

- (1) $\text{Mn} > \text{Cr} > \text{V} > \text{Ti} > \text{Cu}$

- (2) $\text{Cr} > \text{Mn} > \text{V} > \text{Ti} > \text{Cu}$
- (3) $\text{Cr} > \text{V} > \text{Ti} > \text{Mn} > \text{Cu}$
- (4) $\text{Mn} > \text{Fe} > \text{Co} > \text{Pd} > \text{Cu}$

29) Under hydrolytic conditions, the compound used for preparation of chain termination is

- (1) CH_3SiCl_3
- (2) $(\text{CH}_3)_2\text{SiCl}_2$
- (3) $(\text{CH}_3)_4\text{Si}$
- (4) $(\text{CH}_3)_3\text{SiCl}$

30) The correct order of atomic radii trends in decreasing order for lanthanoids-

Given, $\text{Ce}(\text{Z} = 58)$

$\text{Eu}(\text{Z} = 63)$

$\text{Gd}(\text{Z} = 64)$

$\text{Lu}(\text{Z} = 71)$

- (1) $\text{Eu} > \text{Lu} > \text{Ce} > \text{Gd}$
- (2) $\text{Eu} > \text{Ce} > \text{Lu} > \text{Gd}$
- (3) $\text{Eu} > \text{Ce} > \text{Gd} > \text{Lu}$
- (4) $\text{Ce} > \text{Eu} > \text{Gd} > \text{Lu}$

ENGLISH PROFICIENCY

1) **Directions :** in each of the following questions, choose the most appropriate alternative to fill in the blanks.

Choose the option that best completes the sentence:

The results seem inconsistent; you _____ have miscalculated one of the variables.

- (1) should
- (2) must
- (3) might
- (4) could

2) **Directions :** in each of the following questions, choose the most appropriate alternative to fill in the blanks.

Select the sentence that uses the relative pronoun **correctly and precisely**.

- (1) The researcher, whose findings were challenged, defended her methodology confidently.
- (2) The researcher whom findings were challenged defended her methodology confidently.
- (3) The researcher which findings were challenged defended her methodology confidently.
- (4) The researcher that findings were challenged defended her methodology confidently.

3) **Directions :** in each of the following questions, choose the most appropriate alternative to fill in the blanks.

Choose the option with the correct verb form:

The series of seminars on climate resilience _____ scheduled for the coming week.

- (1) are
- (2) were
- (3) has been
- (4) have been

4) Identify the correctly spelled word.

- (1) Irrepressable
- (2) Irrepressible
- (3) Irrepressiblee
- (4) Irrepresssable

5) Choose the word **closest in meaning** to “incisive.”

- (1) Superficial
- (2) Vague
- (3) Penetrating
- (4) Dull

6) Choose the word **opposite in meaning** to “abate.”

- (1) intensify
- (2) retreat
- (3) divide
- (4) negotiate

7) *In a rapidly digitizing world, attention has become an increasingly scarce resource. While technological tools promise efficiency, they often fragment our focus through constant notifications and competing stimuli. Paradoxically, researchers observe that individuals who intentionally cultivate periods of uninterrupted concentration exhibit higher levels of creativity, accuracy, and overall cognitive well-being. The challenge, therefore, lies not in eliminating technology, but in developing mindful practices that allow its advantages without sacrificing mental clarity.*

According to the passage, what is the **main challenge** related to technology ?

- (1) Finding ways to increase the number of notifications
- (2) Eliminating all forms of digital communication
- (3) Using technology while maintaining mental focus
- (4) Ensuring that devices remain efficient

8) *In a rapidly digitizing world, attention has become an increasingly scarce resource. While technological tools promise efficiency, they often fragment our focus through constant notifications and competing stimuli. Paradoxically, researchers observe that individuals who intentionally cultivate periods of uninterrupted concentration exhibit higher levels of creativity, accuracy, and overall cognitive well-being. The challenge, therefore, lies not in eliminating technology, but in developing mindful practices that allow its advantages without sacrificing mental clarity.*

In the passage, the phrase “fragment our focus” most nearly means :

- (1) strengthen concentration
- (2) divide attention
- (3) remove distractions
- (4) improve memory

9) *In a rapidly digitizing world, attention has become an increasingly scarce resource. While technological tools promise efficiency, they often fragment our focus through constant notifications and competing stimuli. Paradoxically, researchers observe that individuals who intentionally cultivate periods of uninterrupted concentration exhibit higher levels of creativity, accuracy, and overall cognitive well-being. The challenge, therefore, lies not in eliminating technology, but in developing mindful practices that allow its advantages without sacrificing mental clarity.*

Which of the following best represents the **logical sequence** of ideas in the passage?

- (1) Technology improves attention → people ignore its drawbacks → focus becomes abundant
- (2) Attention is limited → technology disrupts focus → uninterrupted concentration improves cognition → mindful balance is required
- (3) People dislike technology → constant stimuli increase clarity → concentration is unnecessary
- (4) Technology has no effect on human attention → creativity declines naturally → balance is impossible

10) *In a rapidly digitizing world, attention has become an increasingly scarce resource. While technological tools promise efficiency, they often fragment our focus through constant notifications and competing stimuli. Paradoxically, researchers observe that individuals who intentionally cultivate periods of uninterrupted concentration exhibit higher levels of creativity, accuracy, and overall cognitive well-being. The challenge, therefore, lies not in eliminating technology, but in developing mindful practices that allow its advantages without sacrificing mental clarity.*

Choose the best linker to complete the sentence :

Technology creates powerful opportunities; _____, it can hinder concentration if used without discipline.

- (1) therefore
- (2) nevertheless
- (3) similarly
- (4) consequently

LOGICAL REASONING

1) **Direction :** In each of the following questions, there are two words to the left of the sign :: which are connected in some way. The same relationship obtains between the third word and one of the four alternatives under it. Find the correct alternative in each question.

Medicine : Sickness :: Book : ?

- (1) Ignorance
- (2) Knowledge
- (3) Author

(4) Teacher

2) **Direction :** In each of the following questions, there are two words to the left of the sign :: which are connected in some way. The same relationship obtains between the third word and one of the four alternatives under it. Find the correct alternative in each question.

Bank : River :: Coast : ?

- (1) Flood
- (2) Waves
- (3) Sea
- (4) Beach

3) **Direction :** In each of the following questions, four alternatives are given, out of which three are alike in a certain way while one is different. Choose the odd one.

- (1) JOT
- (2) OUT
- (3) FED
- (4) DIN

4) **Direction :** In each of the following questions, four alternatives are given, out of which three are alike in a certain way while one is different. Choose the odd one.

- (1) 28
- (2) 65
- (3) 126
- (4) 215

5) Choose the missing term out of the given alternatives :

J2Z, K4X, I7V, ?, H16R, M22P

- (1) I11T
- (2) L11S
- (3) L12T
- (4) L11T

6) Find the missing term (?) in the following sequence :

_ A D A C B _ _ B D C C
1 3 _ _ 1 2 4 2 _ _ _ _
a _ _ b _ _ c d ? ? ? ?

- (1) a, c, d, d
- (2) a, d, c, c
- (3) c, a, d, d
- (4) d, c, a, a

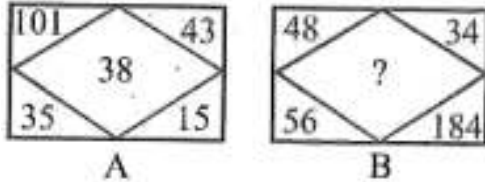
7) **Direction :** In the following question, one term in the number series is wrong. Find out the wrong

term.

46080, 3840, 384, 48, 24, 2, 1

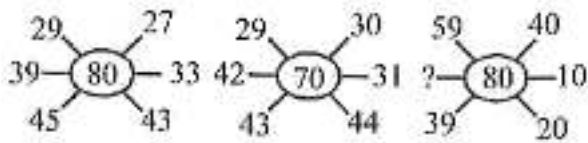
- (1) 384
- (2) 48
- (3) 24
- (4) 2

8) **Directions :** Find the missing character in each of the following questions.



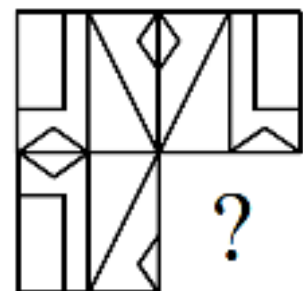
- (1) 127
- (2) 142
- (3) 158
- (4) 198

9) **Directions :** Find the missing character in each of the following questions.

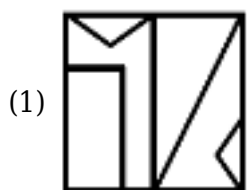


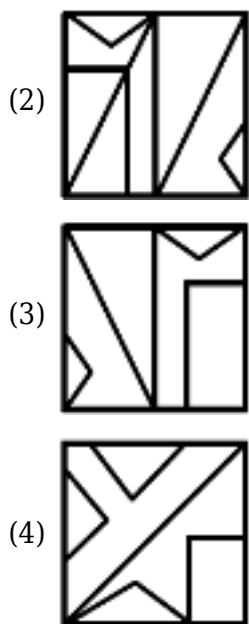
- (1) 49
- (2) 50
- (3) 60
- (4) 69

10) **Directions :** In each of the following questions, a part of the figure is missing. Find out from the

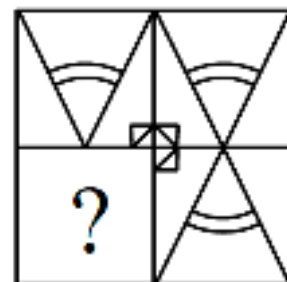


given options (a, b, c and d) the right figure to fit in the missing place.

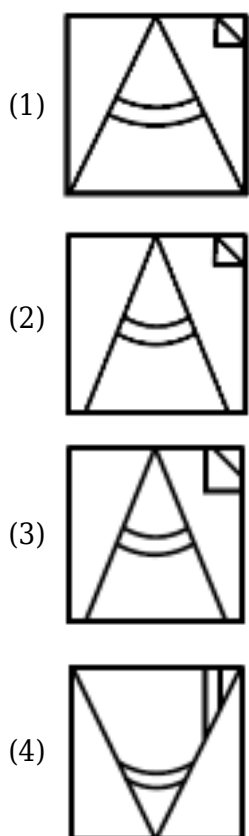




11) **Directions :** In each of the following questions, a part of the figure is missing. Find out from the

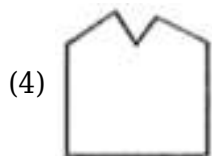
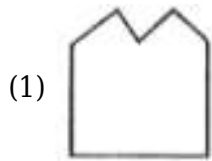
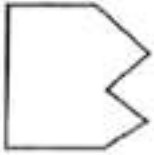


given options (a, b, c and d) the right figure to fit in the missing place.

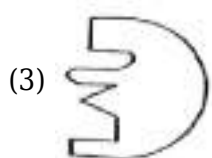


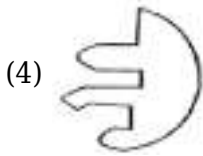
12) In this question a key figure (X) is given followed by five alternative figures. You will have to

select one figure from the alternatives which fits exactly into key figure (X) to form a rectangle. (X)

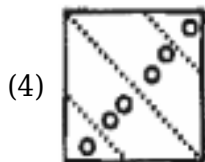
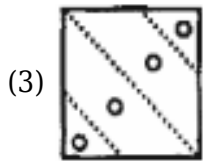
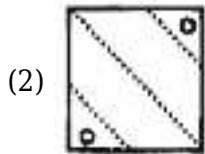
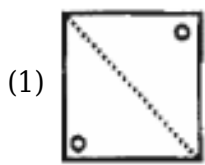
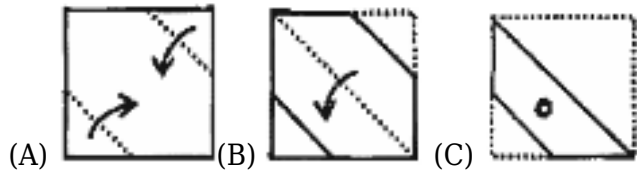


13) In this question a key figure is given followed by four alternative figures. You will have to select one figure from the alternatives which fits exactly into key figure (X) to form a complete circle. (X)

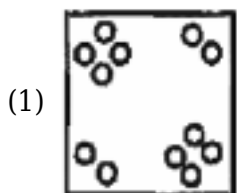
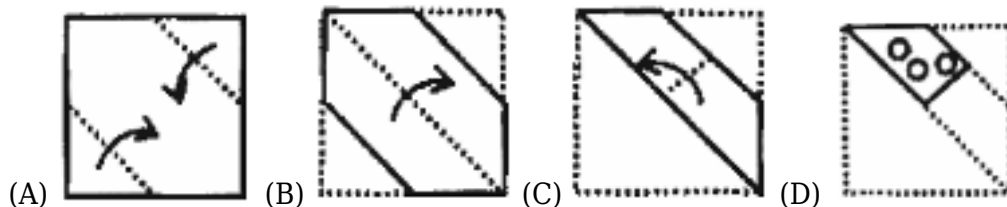


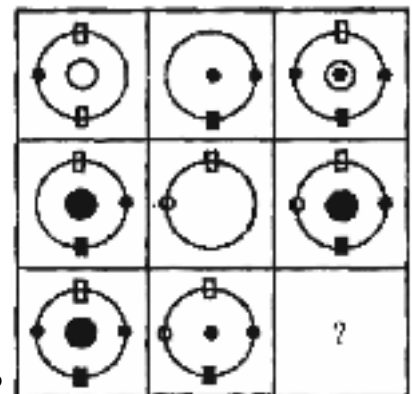
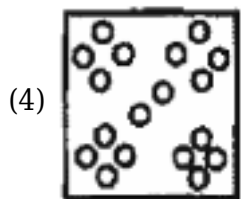
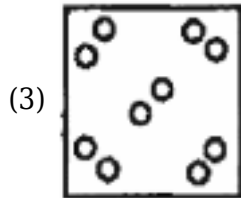
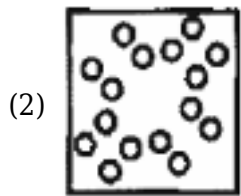


14) **Direction :** In each of the following questions a set of three figures A, B and C showing a sequence of folding of a piece of paper. Fig. (C) shows the manner in which the folded paper has been cut. These three figures are followed by four answer figures from which you have to choose a figure which would most closely resemble the unfolded form of fig, (C).

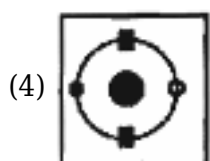
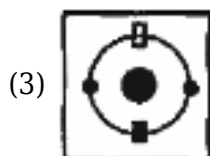
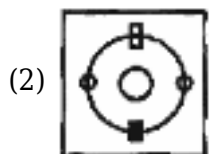
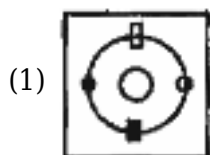


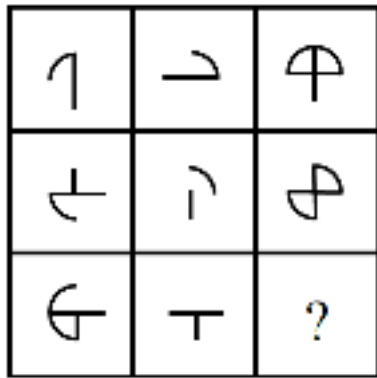
15) **Direction :** In each of the following questions a set of three figures A, B and C showing a sequence of folding of a piece of paper. Fig. (C) shows the manner in which the folded paper has been cut. These three figures are followed by four answer figures from which you have to choose a figure which would most closely resemble the unfolded form of fig, (C).





16) Which of the tiles A to H will fit logically into the missing space?





17)



(1)



(2)

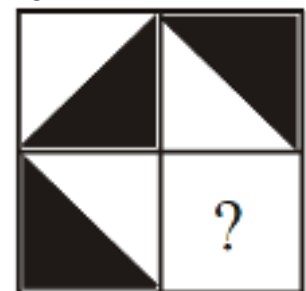


(3)



(4)

18) **Direction** : In each of the following questions, select a figure from amongst the four



(X)

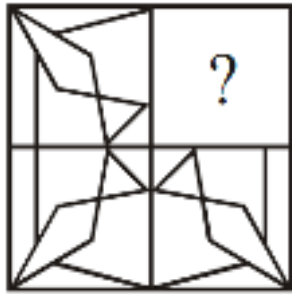
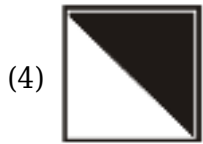
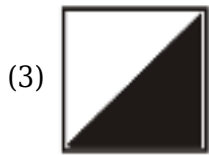
alternatives, which when placed the blank space of fig. (X) would complete



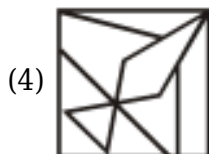
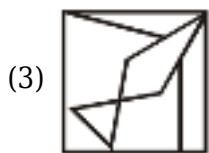
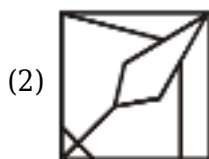
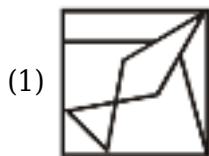
(1)



(2)



19) (X)



20) **Direction :** Read the following information carefully and then answer the question given below it :

Following are the conditions for allotment of flats built by Town Council in the newly developed area of city Gurgaon. The applicant must.

- (A) produce domicile certificate of the State.
- (B) be employed or self-employed in Gurgaon for minimum of 5 years.
- (C) be ready to pay the entire amount in 5 years period.
- (D) not be owner or co-owner (if spouse is owner) of a residential accommodation in the city limit of Gurgaon.
- (E) not be less than 35 years of age as on 31st December 1996.

In case of applicant who satisfies all other criteria except :

- (I) at A above, be referred to President of Town council.

(II) at B above, but is ready to produce ration card of last five years should be referred to Vice-Chairman of House Allotment Committee.

(III) at C above, but is a freedom fighter or an ex-serviceman or first relation i.e. son / daughter / husband / wife of freedom fighter / ex-serviceman should be referred to Vice-Chairman of House Allotment Committee who can give concession per payment upto 15 years in such cases. The last date for receipt of application was 31st December, 1996. Conditions set out in terms of age or duration of stay are to be fulfilled as on 31st December, 1996. Based on these criteria and information provided below, decide the course of action in each case. You are not to assume anything extra. If the data provided is not adequate to decide the given course of action, your answer will be 'data inadequate'. The cases are given to you as on 1st January 1997.

Ms. Rima Mohanty is daughter of a renowned freedom fighter from another state. She is domiciled in the state and employed in the Town Council of Gurgaon for last 6 years. She can pay the entire amount in 5 years. She has completed 34 years on 10th December, 1994. She does not own a house in Gurgaon.

- (1) Refer to the Chairman
- (2) Allot flat
- (3) Do not allot flat
- (4) Refer to the President

MATHEMATICS

1) Let $S_n = \frac{1}{2} + \frac{1}{6} + \frac{1}{12} + \frac{1}{20} + \dots$ upto n terms. If the sum of the first six terms of an A.P. with first term -p and common difference p is $\sqrt{2026S_{2025}}$, then the absolute difference between 20th and 15th terms of the A.P. is

- (1) 25
- (2) 90
- (3) 20
- (4) 45

2) Minimum distance between parabola $y^2 = 8x$ and its image with respect to line $x + y + 4 = 0$ is-

- (1) $2\sqrt{2}$
- (2) $3\sqrt{2}$
- (3) $4\sqrt{2}$
- (4) $8\sqrt{2}$

3) Maximum number of common chords of a parabola and a circle can be equal to

- (1) 2
- (2) 4
- (3) 6
- (4) 8

4) $q(x) = kx^3 + k^2x^2 + k^3x + 1$, $k \in \mathbb{R}$ is divided by $(x + 1)$ to get polynomial $P(x)$ as quotient and zero

as remainder. Roots of the equation $P(x) = 0$ are -

- (1) of opposite signs
- (2) negative
- (3) positive
- (4) imaginary

5) The minimum value of $\frac{\sec^4 \alpha}{\tan^2 \beta} + \frac{\sec^4 \beta}{\tan^2 \alpha}$, $\alpha, \beta \neq \frac{n\pi}{2}$, $n \in \mathbb{Z}$, is

- (1) 4
- (2) 8
- (3) 1
- (4) 16

6) In the sequence 1, 2, 2, 4, 4, 4, 4, 8, 8, 8, 8, 8, 8, 8 the 2011th term is

- (1) 2^{10}
- (2) 2^{11}
- (3) 2^9
- (4) 2^{12}

7)

The variable plane $(2\lambda + 1)x + (3 - \lambda)y + z = 4$ always passes through the line

- (1) $\frac{x}{0} = \frac{y}{0} = \frac{z-4}{1}$
- (2) $\frac{x}{1} = \frac{y}{2} = \frac{z-4}{-3}$
- (3) $\frac{x}{1} = \frac{y}{1} = \frac{z-4}{-7}$
- (4) $\frac{x}{1} = \frac{y}{2} = \frac{z-4}{-7}$

8)

The sum of all the coefficients of the terms in the expansion of $(a + b + c + d)^6$ which contain a but not b is :-

- (1) 3^6
- (2) 2^6
- (3) $3^6 - 2^6$
- (4) 0

9) The locus of the foot of the perpendicular from the centre of the hyperbola $xy = c^2$ on a variable tangent is

- (1) $(x^2 - y^2)^2 = 4c^2xy$
 (2) $(x^2 + y^2)^2 = 2c^2xy$
 (3) $(x^2 - y^2)^2 = 2c^2xy$
 (4) $(x^2 + y^2)^2 = 4c^2xy$

10)

The value of $\sum_{r=1}^{\infty} \tan^{-1} \left(\frac{6^r}{2^{2r+1} + 3^{2r+1}} \right)$ is equal to

- (1) $\frac{\pi}{2}$
 (2) $\cot^{-1} \left(\frac{3}{2} \right)$
 (3) $\tan^{-1} \left(\frac{3}{2} \right)$
 (4) $\tan^{-1}(3)$

11)

Four numbers are chosen at random without replacement from numbers $\{1, 2, 3, \dots, 12\}$. The probability that their minimum is 5, given that their maximum is 10, is

- (1) $\frac{1}{14}$
 (2) $\frac{1}{7}$
 (3) $\frac{5}{14}$
 (4) $\frac{3}{14}$

12) The value of $\int_{1/e}^{\tan x} \frac{t}{1+t^2} dt + \int_{1/e}^{\cot x} \frac{1}{t(1+t^2)} dt$, where $x \in (\pi/6, \pi/3)$, is equal to :

- (1) 0
 (2) 2
 (3) 1
 (4) cannot be determined

13) $\lim_{n \rightarrow \infty} \left(\frac{(\frac{n}{3} + 1)(\frac{n}{3} + 2) \dots (n)}{(\frac{n}{3})^{2n/3}} \right)^{3/n}$ is

- (1) $3\sqrt[n]{n^3 - 2}$
 (2) $3\sqrt[n]{n^3 + 2}$

(3) $\frac{27}{e^2}$

(4) $2^n 3 - 2$

14) $\lim_{x \rightarrow 0} \frac{(2401 + x)^{1/4} - 7}{49 - (2401 + x)^{1/2}}$ equals

(1) $\frac{1}{7}$

(2) $-\frac{1}{14}$

(3) $\frac{1}{14}$

(4) $-\frac{1}{7}$

15) Let $f(x) = \begin{cases} \frac{x^{2^{32}} - 2^{32}x + 4^{16} - 1}{(x-1)^2}, & x \neq 1 \\ k, & x = 1 \end{cases}$, then the value of k so that the function is continuous at x = 1 is

(1) $2^{63} - 2^{31}$

(2) $2^{64} - 2^{33}$

(3) $(2^{16} + 1)(2^8 + 1)(2^4 + 1)(2^2 + 1)(2^{32} + 2^1)$

(4) $(2^{32} + 1)(2^{16} + 1)(2^8 + 1)(2^4 + 1)(2^2 + 1)(2^{32} + 2^{31})$

16) Three circles C_1 , C_2 and C_3 with radii 2, r, 8 respectively are given. They are placed such that C_2 lies to the right of C_1 and touches it externally, C_3 lies to the right of C_2 and touches it externally. Further, there exist two straight lines each of which is a direct common tangent simultaneously to all three circles, then r is _____

(1) 5

(2) 6

(3) 7

(4) 4

17) If A and B be two sets having 4 elements in common, if $n(A) = 5$, $n(B) = 7$ then $n((A \times B) \cap (B \times A))$ is

(1) 8

(2) 4

(3) 16

(4) 35

18) If the function $f(x) = x^3 - 6x^2 + ax + b$ satisfies Rolle's theorem in the interval $[1, 3]$ and

$$f' \left(\frac{2\sqrt{3}+1}{\sqrt{3}} \right) = 0, \text{ then}$$

- (1) $a = 11$
- (2) $a = -6$
- (3) $a = 6$
- (4) $a = 1$

19) If the side of an equilateral triangle increase at a rate of $\sqrt{3}$ cm/sec and area increase at the rate of $12\text{cm}^2/\text{sec}$, then the side of equilateral triangle is

- (1) 2
- (2) 4
- (3) 6
- (4) 8

20) The number of solution(s) of the equation $x^2 2^{x+1} + 2^{|x-3|+2} = x^2 \cdot 2^{|x-3|+4} + 2^{x-1}$ lying in the interval $(-2, 2)$ is/are

- (1) 1
- (2) 2
- (3) 3
- (4) 4

21) Let $f : \mathbb{R} \rightarrow (0, 1)$ be a continuous function. Then, which of the following function(s) has(have) the value zero at some point in the interval $(0, 1)$?

(1) $e^x - \int_0^x f(t) \sin t \, dt$

(2) $1 + x^{2021} - (f(x))^{2022}$

(3) $f(x) + \int_0^{\frac{\pi}{2}} f(t) \sin t \, dt$

(4) $1 - x^{2021} - (f(x))^{2022}$

22) The total number of positive integral solution of $15 < x_1 + x_2 + x_3 \leq 20$ is equal to:

- (1) 685
- (2) 785
- (3) 1125
- (4) None of these

23) Area of trapezium whose vertices lie on the parabola $y^2 = 4x$ and its diagonal pass through $(1, 0)$ and having length $25/4$ units each, its

- (1) $\frac{75}{4}$ sq. units
 (2) $\frac{625}{16}$ sq. units
 (3) $\frac{25}{4}$ sq. units
 (4) $\frac{25}{8}$ sq. units

24)

$2\tan^{-1}(\cos x) = \tan^{-1}(\operatorname{cosec}^2 x)$ then $x =$

- (1) $\frac{\pi}{2}$
 (2) π
 (3) $\frac{\pi}{6}$
 (4) $\frac{\pi}{3}$

25) Tangent drawn at any point P on a curve meets x-axis at Q such that circumcentre of ΔPOQ has abscissa half that ordinate. The differential equation to such a curve is

- (1) $\frac{dy}{dx} = \frac{x+2y}{2x-y}$
 (2) $\frac{dy}{dx} = \frac{2y-x}{2x+y}$
 (3) $\frac{dy}{dx} = \frac{2y+y}{2x-y}$
 (4) None of these

26) The area (in sq. units) of the region described by :

$\{(x, y) : y^2 \leq 2x \text{ and } y \geq 4x - 1\}$ is :

- (1) $\frac{4}{32}$
 (2) $\frac{5}{64}$
 (3) $\frac{15}{64}$
 (4) $\frac{9}{32}$

27) Let $y = y(x)$ be the solution of the differential equation $\sec x \, dy + \{2(1-x)\tan x + x(2-x)\} \, dx = 0$ such that $y(0) = 2$. Then $y(2)$ is equal to :

- (1) 2
 (2) $2\{1 - \sin(2)\}$

(3) $2\{\sin(2) + 1\}$

(4) 1

28) Sum of all the real values of x satisfying the equation $\log_2(x^2 - x) \log_2\left(\frac{x-1}{x}\right) + (\log_2 x)^2 = 4$ is

(1) $\frac{25}{4}$

(2) 5

(3) $\frac{29}{4}$

(4) 7

29) System of equations in x , y and z

$$x + \lambda y + \lambda^2 z = 0$$

$\lambda^2 x + y + \lambda z = 0$ $\lambda x + \lambda^2 y + z = 0$ has non-trivial solution then λ is equal to
(Where ω , ω^2 are non-real cube roots of unity)

(1) 1 only

(2) ω only

(3) ω^2 only

(4) all of the above

30) If the roots of $(k+1)x^2 - (20k+14)x + 91k+40 = 0$ are α , β where $\alpha < \beta$, $k > 0$ then smaller root lies in the interval:

(1) (4, 7)

(2) (7, 10)

(3) (10, 3)

(4) (2, 4)

31) If z_1 and z_2 are two unimodular complex numbers that satisfy $z_1^2 + z_2^2 = 5$, then $(z_1 - \bar{z}_1)^2 + (z_2 - \bar{z}_2)^2$ is equal to -

(1) 6

(2) 5

(3) 9

(4) 10

32) Coefficient of x^{n-6} in the expansion

$$\left[\frac{x}{2} - \left(\frac{{}^nC_0 + {}^nC_1}{{}^nC_0} \right) \right] \left[\frac{x}{2} - \left(\frac{{}^nC_1 + {}^nC_2}{{}^nC_1} \right) \right] \left[\frac{x}{3} - \left(\frac{{}^nC_2 + {}^nC_3}{{}^nC_2} \right) \right] \dots \left[\frac{x}{n} - \left(\frac{{}^nC_{n-1} + {}^nC_n}{{}^nC_{n-1}} \right) \right]$$

is equal to

(where $n! = n \cdot (n - 1) \cdot (n - 2) \dots 3 \cdot 2 \cdot 1$)

(1) ${}^nC_6(n + 1)^6$

(2) ${}^nC_6 \cdot n^6$

(3) ${}^nC_6(n + 2)^6$

(4) ${}^nC_5(n + 1)^5$

33) If $A = \begin{bmatrix} 1 & 2 & 0 \\ 2 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$ and $k_1 A^{-1} = A^2 + k_2 A - 5I$; then find the value of k_1 and k_2 ?

(1) $k_1 = 1; k_2 = 1$

(2) $k_1 = 5; k_2 = 1$

(3) $k_1 = 1; k_2 = 5$

(4) $k_1 = -1; k_2 = -5$

34) If $A = \{1, 2, 3, \dots, 9\}$ and R be the relation in $A \times A$ defined by $(a, b) R (c, d)$ if $a + d = b + c$, for all $a, b, c, d \in A$ is an equivalence relation, then the equivalence class of $(2, 5)$ is :

(1) $\{(1, 4), (2, 5), (3, 6), (4, 7), (5, 8), (8, 9)\}$

(2) $\{(2, 4), (3, 5), (4, 6), (5, 7), (6, 8), (7, 9)\}$

(3) $\{(1, 4), (2, 5), (3, 6), (4, 7), (5, 8), (6, 9)\}$

(4) None of these

35) The negation of $p \rightarrow (\sim p \vee q)$ is

(1) $p \vee (p \vee \sim q)$

(2) $p \rightarrow \sim (p \vee q)$

(3) $p \rightarrow q$

(4) $p \wedge \sim q$

36) If two events A and B are such that $P(A^c) = 0.3$, $P(B) = 0.4$ and $P(A \cap B^c) = 0.5$, then value of $P\left(\frac{B}{A \cup B^c}\right)$ is equal to ?

(1) $\frac{1}{4}$

(2) $\frac{1}{2}$

(3) $\frac{3}{4}$

(4) $\frac{3}{8}$

37) Let $\vec{A} = \hat{i} - 3\hat{j} + 4\hat{k}$, $\vec{B} = 6\hat{i} + 4\hat{j} - 8\hat{k}$, $\vec{C} = 5\hat{i} + 2\hat{j} + 5\hat{k}$ and a vector $\vec{R}$ satisfies $\vec{R} \times \vec{B} = \vec{C} \times \vec{B}$,

$\vec{R} \cdot \vec{A} = 0$, then the value of $\frac{|\vec{B}|}{|\vec{R} - \vec{C}|}$ is

- (1) 1
- (2) 2
- (3) 3
- (4) 4

38)

If the projection of the line $\frac{x}{2} = \frac{y-1}{2} = \frac{z-1}{1}$ on a plane P is $\frac{x}{1} = \frac{y-1}{1} = \frac{z-1}{-1}$. Then the distance of plane P from origin is :-

- (1) $\sqrt{3}$
- (2) $\sqrt{\frac{3}{2}}$
- (3) $\sqrt{6}$
- (4) $\frac{2}{\sqrt{3}}$

39) If the lines $\frac{x-1}{2} = \frac{y-2}{0} = \frac{z+1}{k}$ and $\frac{x+3}{1} = \frac{y-1}{k} = \frac{z-k}{-2}$ are coplaner, then

- (1) No real value of k exist
- (2) Exactly one real value of k exists
- (3) Exactly two real value of k exists
- (4) Exactly three real value of k exists

40) Mean of 100 observation is 45. It was later found that two observations 19 and 31 were incorrectly recorded as 91 and 13. The correct mean is :

- (1) 44
- (2) 44.46
- (3) 45
- (4) 45.54

ANSWER KEYS

PHYSICS

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	3	3	3	2	1	1	3	4	2	1	1	2	2	2	1	1	3	1	1	1
Q.	21	22	23	24	25	26	27	28	29	30										
A.	3	1	1	3	3	4	1	4	4	1										

CHEMISTRY

Q.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A.	3	3	3	2	3	3	4	1	1	3	1	2	2	3	3	2	4	1	2	2
Q.	51	52	53	54	55	56	57	58	59	60										
A.	2	2	1	2	4	3	4	3	4	3										

ENGLISH PROFICIENCY

Q.	61	62	63	64	65	66	67	68	69	70
A.	2	1	3	2	3	1	3	2	2	2

LOGICAL REASONING

Q.	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
A.	1	3	2	4	4	4	3	2	4	3	1	3	2	3	2	3	3	2	3	2

MATHEMATICS

Q.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
A.	1	1	3	4	2	1	4	3	4	2	1	3	3	2	1	4	3	1	4	2
Q.	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
A.	4	1	1	4	1	4	1	1	4	1	1	1	2	3	4	1	2	2	3	2

SOLUTIONS

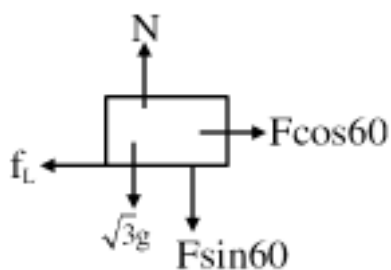
PHYSICS

$$1) [\alpha] = [\beta] = \left[\frac{kt}{x} \right] = \frac{[ML^2T^{-2}]}{[L]} = [MLT^{-2}]$$

2)

$$80 = \frac{1}{2} \times 10 \times t^2 \Rightarrow t = 4 \text{ sec}$$

$$10 \times 4 + v \times 4 = 60 \Rightarrow v = 5 \text{ m/s}$$



4)

$$N = F\sin 60 + \sqrt{3}g$$

$$f_L = \mu(F\sin 60 + \sqrt{3}g)$$

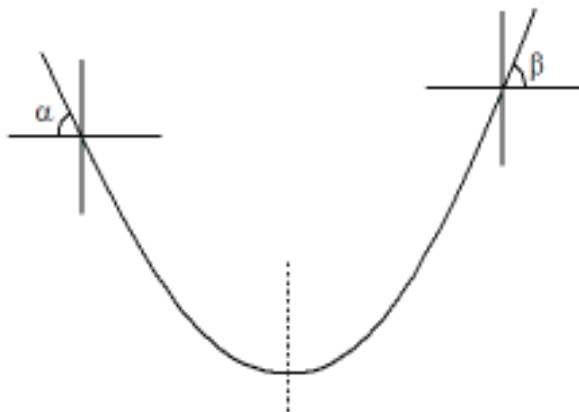
$$f_L = \frac{F}{4} + \frac{g}{2}$$

$$F\cos 60 = f_L$$

$$\frac{F}{2} = \frac{F}{4} + 5$$

$$\frac{F}{4} = 5 \Rightarrow F = 20\text{N}$$

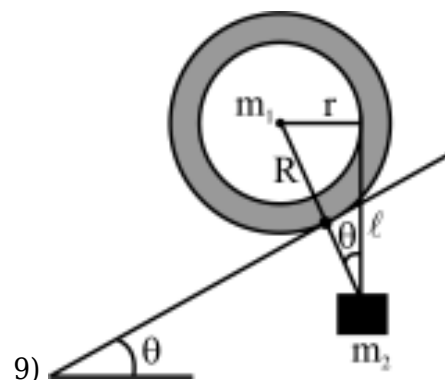
$$5) T_1 \cos \alpha = T_3 = T_2 \cos \beta$$



$$T_1 \sin \alpha + T_2 \sin \beta = mg$$

$$\Rightarrow mg = T_1 \sqrt{1 - \left(\frac{T_3}{T_1}\right)^2} + T_2 \sqrt{1 - \left(\frac{T_3}{T_2}\right)^2}$$

$$\Rightarrow m = \frac{\sqrt{T_1^2 - T_3^2} + \sqrt{T_2^2 - T_3^2}}{g}$$

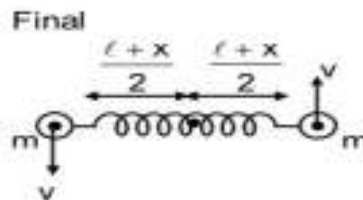
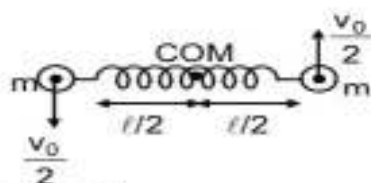
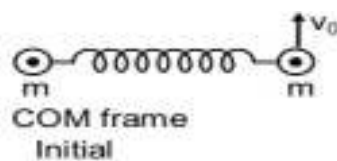


$$\tan \theta = \frac{r}{\ell}$$

$$\ell = \frac{r}{\tan \theta}$$

$$\left(\frac{\ell}{\cos \theta} - R \right) m_2 = m_1 R$$

$$\left(\frac{\ell}{\sin \theta} - R \right) m_2 = m_1 R$$



10) COAM

$$2m \left(\frac{V_0}{2} \right) \left(\frac{\ell}{2} \right) = 2mV \left| \frac{\ell+x}{2} \right|$$

$$\frac{V_0 \ell}{2} = V(\ell+x)$$

COME

$$2 \left(\frac{1}{2} m \left(\frac{V_0}{2} \right)^2 \right) = 2 \left(\frac{1}{2} m V^2 \right) + \frac{1}{2} K x^2$$

$$\frac{1}{4} m V_0^2 = m \frac{V_0^2 \ell^2}{4(\ell+x)^2} + \frac{1}{2} K x^2$$

$$\frac{1}{4} m V_0^2 = \frac{1}{4} m V_0^2 \left(1 + \frac{x}{\ell} \right)^{-2} + \frac{1}{2} K x^2$$

$$\frac{1}{4} m V_0^2 = \frac{1}{4} m V_0^2 \left(1 - \frac{2x}{\ell} \right) + \frac{1}{2} K x^2$$

$$\frac{1}{4} m V_0^2 = \frac{1}{4} m V_0^2 - \frac{1}{2} \frac{m V_0^2}{\ell} x + \frac{1}{2} K x^2$$

$$\frac{1}{2}Kx^2 = \frac{1}{2} \frac{mV_0^2}{\ell} x \Rightarrow Kx = \frac{mV_0^2}{\ell}$$

$$x = \frac{mV_0^2}{K\ell^2}$$

12) The strain developed in A is comparatively less as compared to B.

13) Velocity gradient = $\frac{0.5}{\frac{2.5}{2} \times 10^{-2}}$

as force on the plate due to viscosity is from upper as well as lower portion of the oil, equal from each part,

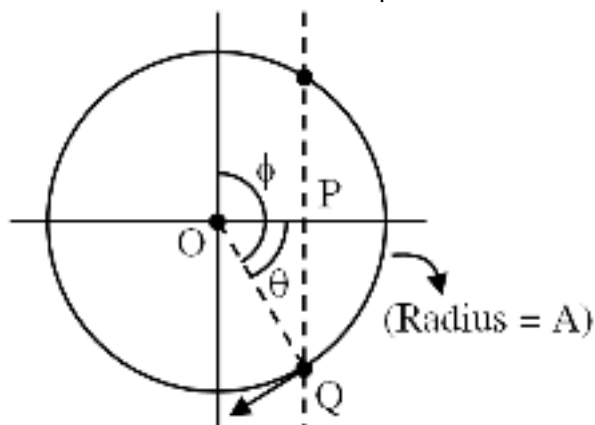
Then, $F = 2\eta A \frac{dv}{dz} = 2 \times \eta \times (0.5) \frac{0.5}{1.25 \times 10^{-2}}$



$\Rightarrow \eta = 2.5 \times 10^{-2} \text{ kg - sec/m}^2$

14) **Concept :** Use of general equation of SHM for displacement, i.e, $x = A \sin(\omega t + \phi)$

Solution : We need to find ϕ .



In ΔOPQ , $\cos \theta = \frac{A/2}{A} = \frac{1}{2}$

$\theta = \frac{\pi}{3}$

$\phi = \frac{\pi}{2} + \frac{\pi}{3} = \frac{5\pi}{6}$

$x = A \sin \left(\omega t + \frac{5\pi}{6} \right)$

$= A \sin \left(\frac{2\pi t}{T} + \frac{5\pi}{6} \right)$

16) $f_1 = \frac{n}{2(L+e)} v$

$e = 2 \times 0.6r = 6 \text{ cm}$

$160 = \frac{1}{2 \times 1} \times v$

$\Rightarrow v = 320 \text{ m/s}$

$$17) \text{ Rate of cooling} = \frac{dT}{dt} = \frac{e\sigma A}{ms} [T_b^4 - T_c^4]$$

$$\left[\frac{dT}{dt} \right]_A = \frac{1 \times \sigma A}{m \times s_A} [(2T)^4 - (T)^4]$$

$$\left[\frac{dT}{dt} \right]_B = \frac{0.3 \times \sigma A}{m \times s_B} [(3T)^4 - (T)^4]$$

$$\frac{\left[\frac{dT}{dt} \right]_A}{\left[\frac{dT}{dt} \right]_B} = \frac{15/s_A}{\frac{0.3 \times 80}{2s_A}} = \frac{300}{3 \times 80} = \frac{5}{4}$$

$$19) \text{ Due to a disc, electric field on axis is given by } E = \frac{\sigma}{2\epsilon_0} \left[1 - \frac{x}{\sqrt{R^2 + x^2}} \right]$$

$$\square E = \frac{\sigma}{2\epsilon_0} \left[1 - \frac{h}{\sqrt{(2a)^2 + h^2}} \right] - \frac{\sigma}{2\epsilon_0} \left[1 - \frac{h}{\sqrt{a^2 + h^2}} \right]$$

$$= \frac{\sigma}{2\epsilon_0} \left[\frac{h}{2a\sqrt{1 + \frac{h^2}{4a^2}}} - \frac{h}{a\sqrt{1 + \frac{h^2}{a^2}}} \right]$$

$$= \frac{\sigma}{2\epsilon_0} \frac{h}{a} \left[\frac{1}{2} \left(1 - \frac{h^2}{2 \times 4a^2} \right) - \left(1 - \frac{1h^2}{2a^2} \right) \right]$$

$$= \frac{ah}{2\epsilon_0 a} \left[\frac{1}{2} - 1 \right] = \frac{\sigma h}{4\epsilon_0 a}$$

20)

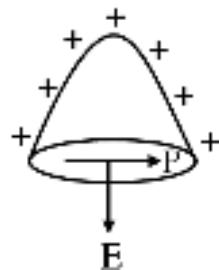
Explaining the Question :-

Force dipole and its type of equilibrium -

Concept:-

dipole and type of equilibrium

Solution :-



There will be no force in circular plane hence in this plane equilibrium will be neutral

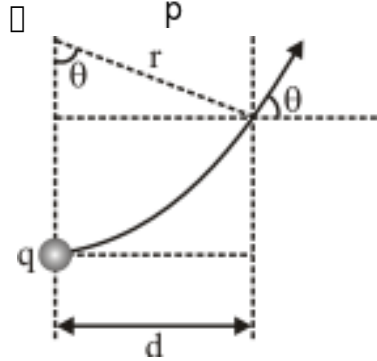
Final Answer :- (Equilibrium will be neutral)

$$22) \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}} = K\ell_{AP} = \left(\frac{10}{10+10} \right) \frac{10}{1} \ell_{AP}$$

23) From figure it is clear that

$$\sin \theta = \frac{d}{r} \text{ also } r = \frac{p}{dB}$$

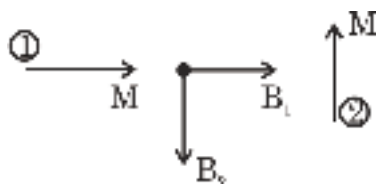
$$\sin \theta = \frac{Bqd}{p}$$



24)

$$\text{Along } y \quad v_y^2 = 2 \times \frac{qE}{m} \times y$$

$$\text{Net speed} = \sqrt{v^2 + v_y^2}$$



25)

Magnetic field at axial point

$$B_1 = \frac{2kM}{d^3}$$

Magnetic field at equatorial point due to (2)

$$B_2 = \frac{kM}{d^3}$$

$$26) \frac{1}{10} = (1.5 - 1) \left(\frac{1}{R} + \frac{1}{R} \right) \Rightarrow \frac{1}{10} = 0.5 \times \frac{2}{R}$$

$$\Rightarrow R = 10 \text{ cm.}$$

Refraction from 1st surface,

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \Rightarrow \frac{1.5}{v_1} - \frac{1}{-20} = \frac{1.5 - 1}{+10}$$

$$\Rightarrow v_1 = \infty$$

$$\text{for the second surface, } \frac{2}{v} - \frac{1.5}{\infty} = \frac{2 - 1.5}{-10}$$

$$\Rightarrow v = -40 \text{ cm}$$

27) As ratio of slit widths = Ratio of intensities

$$\therefore \frac{I_1}{I_2} = \frac{9}{4} \text{ or } \frac{a_1^2}{a_2^2} = \frac{9}{4} \Rightarrow \frac{a_1}{a_2} = \frac{3}{2}$$

$$a_{\max} = a_1 + a_2 = 3 + 2 = 5 ; a_{\min} = 3 - 2 = 1$$

$$\frac{I_{\max}}{I_{\min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2} = \frac{(3 + 2)^2}{(3 - 2)^2} = \frac{25}{1}$$

$$28) 13.6 + 2.4 = \frac{hc}{\lambda}$$

29) Activity will be after

one half life = 50%

two half lives = 25%

three half lives = 12.52%

Four half lives = 6.25%

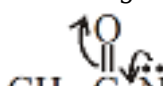
five half lines = 3.125% $\approx$ 3%

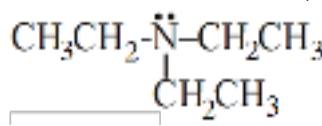
$\Rightarrow$ required time = $5 \times 12.5 + 7$ yrs (as printed)
 ≈ 70 yrs

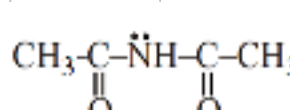
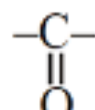
$$30) \frac{6}{0.125} = R + \frac{1}{\left(\frac{1}{8} + \frac{1}{16} + \frac{1}{16}\right)}$$

CHEMISTRY

31) For the given compound :

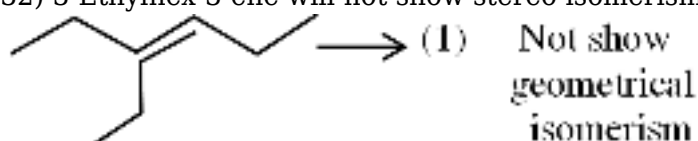
(1)  CH3-C(=O)-NH-CH2CH3 ; L.P. on nitrogen is delocalised

(2)  CH3CH2-N(CH2CH3)-CH2CH3 ; L.P. on nitrogen is delocalised

(3)  CH3-C(=O)-NH-C(=O)-CH3 ; L.P. on nitrogen is delocalised due to conjugation with 
 (Hence least basic)

(4) CH3-CH2-NH-CH2-CH3 ; L.P. on nitrogen is delocalised

32) 3-Ethylhex-3-ene will not show stereo isomerism it's diagram is.



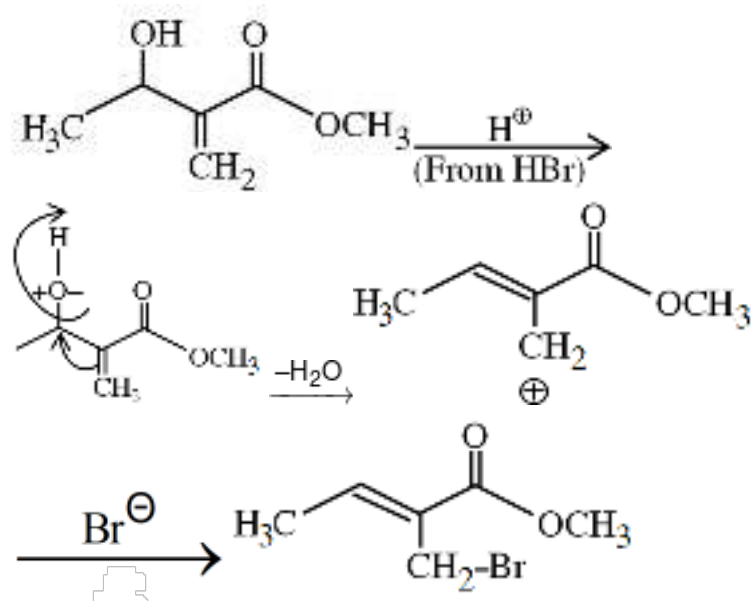
(2) Not show optical isomerism

33) Ambident nucleophile

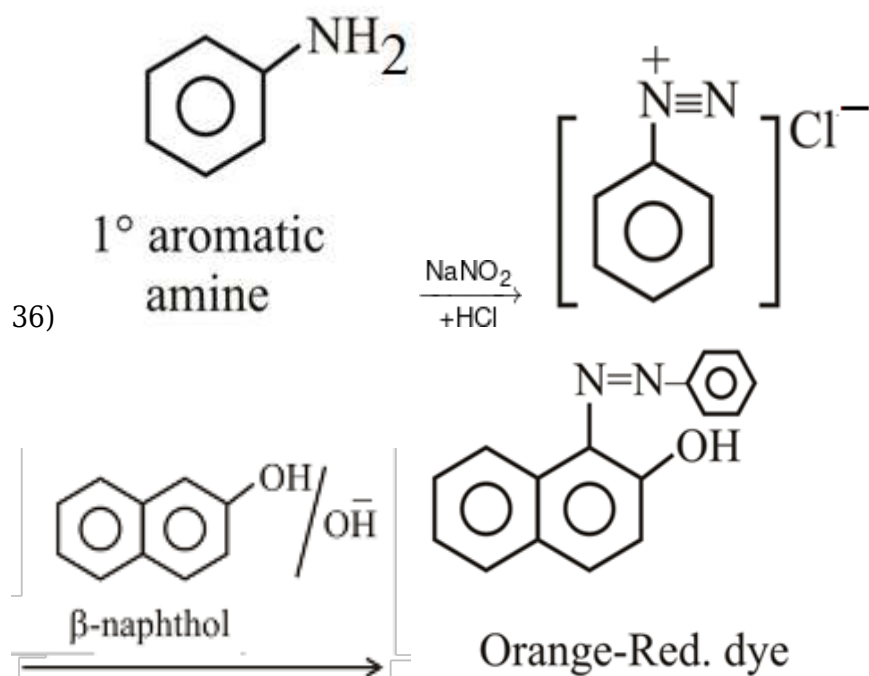
(A) KCN & AgCN

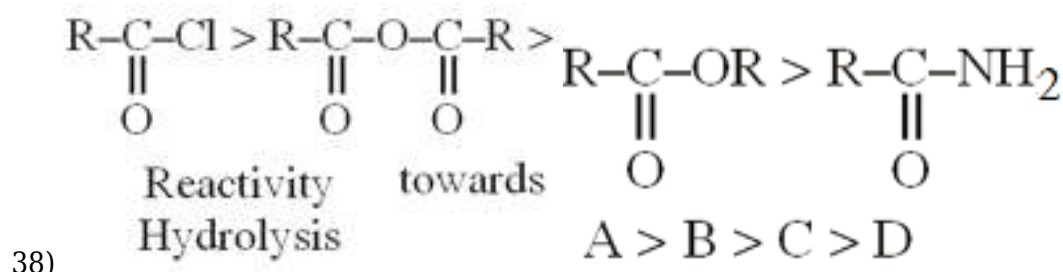
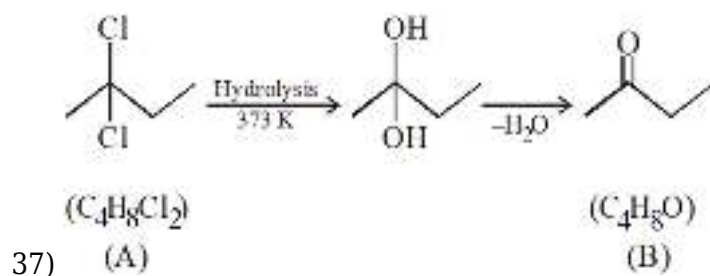
(C) AgNO₂ & KNO₂

34)



35) The correct answer option is (C)





39) Primary amines react with Para Toluene sulfonyl chloride to form a precipitate that is soluble in NaOH.

Secondary amines reacts with para toluene sulfonyl chloride to give a precipitate that is insoluble in NaOH.

Tertiary amines do not react with para toluen.

40) The secondary structure of protein includes two type :

(a) α -Helix (b) β -pleated sheet

In α -Helix structure, the poly peptide chain is coil around due to presence of Intramolecular H-Bonding.

41)

Explanation Question: Question is asking about difference in wavelength of first and last line of Lyman series for H^+ .

Concept: This question is based on atomic line spectrum.

Solution: Wave length = $\frac{1}{\text{Wave number}}$
 Wave number for a line in spectrum

$$\bar{\nu} = RZ^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

Z = 2 Lyman series $n_1 = 1$

First line $n_2 = 2$, last line $n_2 = \infty$

$$\bar{\nu}_{L_1} = R_H 2^2 \left[\frac{1}{1^2} - \frac{1}{2^2} \right] = 4R_H \times \frac{3}{4} \Rightarrow \lambda_{L_1} = \frac{1}{3R_H}$$

$$\bar{\nu}_{L_{\text{Last}}} = R_H 2^2 \left[\frac{1}{1^2} - \frac{1}{\infty^2} \right] = 4R_H \Rightarrow \lambda_{L_{\text{Last}}} = \frac{1}{4R_H}$$

So, $\lambda_{L_1} - \lambda_{L_{\text{Last}}} = \frac{1}{3R_H} - \frac{1}{4R_H}$

$$= \frac{1}{12R_H}$$

Final Answer: Option (1). $\frac{1}{12R_H}$

42) Question Explanation:

Find molality.

Concept:

This question is based on interconversion of concentration terms.

Solution:

$$\text{molality} = \frac{\text{mole of solute}}{\text{mass of solvent (kg)}}$$

$$\text{mass of solution} = d \times v$$

$$= 1 \times 1000 = 1000 \text{ g} = 1 \text{ kg}$$

$$\text{mass of solvent} = 1000 - 200 = 800 \text{ g}$$

$$\text{molality} = \frac{200}{200} \times \frac{1000}{(1000 - 200)} = 1.25 \text{ m}$$

Final Answer: Option (2)

43)

Question Explanation:

Calculation of K_c .

Concept:

This question is based on calculation of K_c .

Solution:

$$\begin{array}{rcl}
 2\text{SO}_2(\text{g}) & + & \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) \\
 \frac{12.8}{64} & & \frac{9.6}{32} \quad \quad \frac{48}{80} \\
 t = t_{\text{eq}} & & \\
 = 0.2 \text{ mole} & = & 0.3 \text{ mole} \quad = 0.6 \text{ mole} \\
 & & \left(\frac{0.6}{1}\right)^2 \\
 K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]} = \frac{\left(\frac{0.6}{1}\right)^2}{\left(\frac{0.2}{1}\right)^2 \left(\frac{0.3}{1}\right)} = \frac{0.6 \times 0.6}{0.2 \times 0.2 \times 0.3} = 30
 \end{array}$$

Final Answer:

The correct option is (2).

44) Explain Question: The question asks which of the given curves does not represent Boyle's Law.

Concept: Boyle's Law states that for a given amount of gas at constant temperature, the pressure (P) is inversely proportional to volume (V).

Mathematically: $PV = \text{constant} \rightarrow P \propto 1/V$

Solution: Boyle's law is also called constant temperature law.

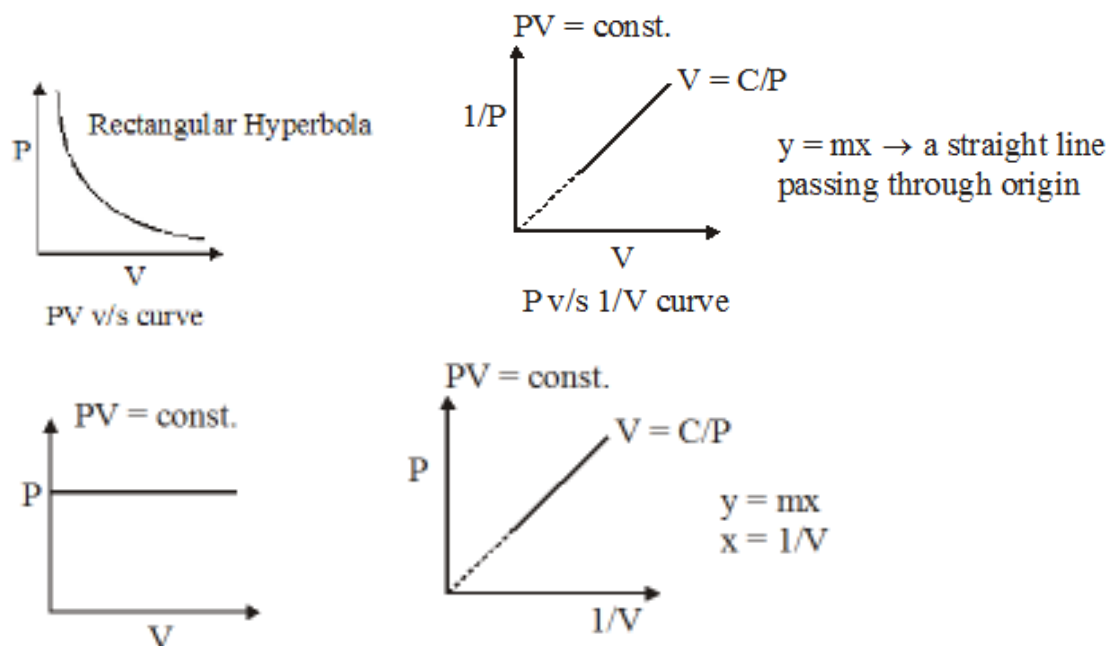
For an ideal gas at an particular temperature the pressure becomes inversally proportional to volume of gas.

$PV = nRT$ (Ideal gas equation)

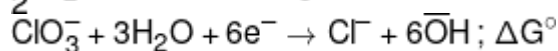
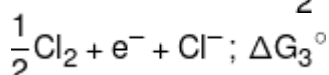
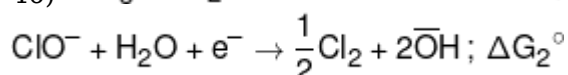
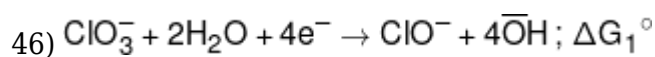
If temperature is kept constant.

$PV = \text{constant}$

$$P \propto \frac{1}{V}$$



Final Answer: Option (3) does not represent the boyles law.



$$\Delta G^\circ = \Delta G_1^\circ + \Delta G_2^\circ + \Delta G_3^\circ$$

$$-6 \times F \times E^\circ = -4 \times F \times 0.54 - 1 \times F \times 0.45 - 1 \times F \times 1.07$$

$$E^\circ = \frac{3.68}{6} = 0.61 \text{ V}$$

Option : (2)

$$47) n \times \frac{5R}{2} (T_2 - 350) = -P_{\text{ext}} \left(\frac{nRT_2}{P_2} - \frac{nRT_1}{P_1} \right)$$

$$T_2 = 450 \text{ K}$$

$$W = nC_v (T_2 - T_1)$$

$$= 2 \times \frac{5R}{2} (450 - 350)$$

$$= 500 R$$

48) Question Explanation:

Find the radius of largest atom.

Concept:

This question is based on packing in ionic solids.

Solution:

The largest atom that can occupy an octahedral void in an FCC structure.

$$\frac{r^+}{r^-} = 0.414 \quad \text{or} \quad r^- = \frac{r^+}{0.414}$$

$$\frac{a}{2} = r^+ + r^-$$

$$\frac{a}{2} = r^+ + \frac{r^+}{0.414}$$

$$\frac{362}{2} = r^+ \left(1 + \frac{1}{0.414} \right)$$

$$r^+ \simeq 53 \text{ pm}$$

Final Answer:

The correct option is (1)

49)

Explain Question :

Calculate required salt concentration for a specific buffer pH.

Concept:

Henderson-Hasselbalch Equation.

Solution:

To find the moles of salt needed, we relate pH, pK_a , and the ratio of $[\text{Salt}]/[\text{Acid}]$ using the buffer formula.

Calculation:

$$\bullet \quad pK_a = -\log(2 \times 10^{-5}) = 5 - 0.3 = 4.7$$

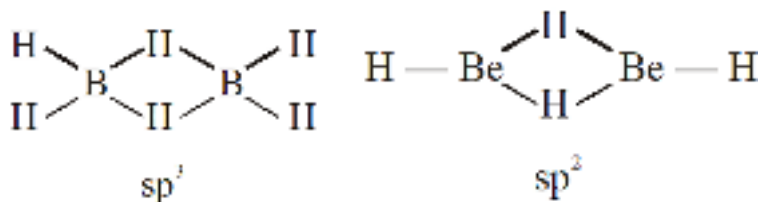
$$\bullet \quad 4 = 4.7 + \log\left(\frac{n_{\text{salt}}}{0.1}\right).$$

$$\bullet \quad -0.7 = \log\left(\frac{n_{\text{salt}}}{0.1}\right) \Rightarrow \frac{n_{\text{salt}}}{0.1} = 10^{-0.7} \approx 0.2$$

$$\bullet \quad n_{\text{salt}} = 0.1 \times 0.2 = 0.02$$

Final Answer: Option (2)

51) N has more IE_1 than O due to more stable configuration.

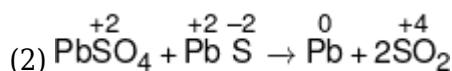


52)

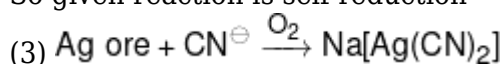
53)

- (A) EDTA is hexadentate, ligand and makes 5 chelate rings with central metal ion
(B) Dien is tridentate ligand and makes 2 rings with central metal ion
(C) en is bidentate and makes 1 chelate ring with central metal ion

54)



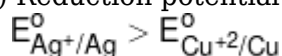
So given reaction is self reduction



(It is leaching process)

→ given reaction is reduction reac^h by Zn.

(4) Reduction potential



So displacement of Cu^{+2} not possible by Ag^+

55) **Question Explanation:** Identifying the incorrect statement among qualitative tests for some metal ions.

Concept: Qualitative Inorganic Analysis.

Ferrous ion gives white ppt with $\text{K}_4[\text{Fe}(\text{CN})_6]$

Final Answer: 4. Ferrous ion gives blue ppt with $\text{K}_4[\text{Fe}(\text{CN})_6]$ solution.

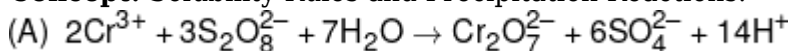
56)

Co-ordination number of Li^+ is 4 because lithium can only use it's 2s and 2p orbitals.

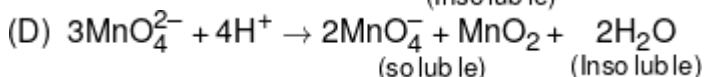
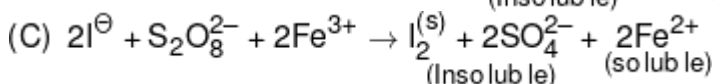
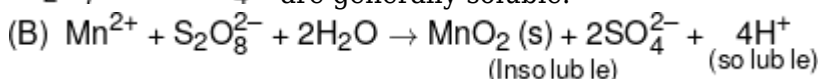
Mg^{2+} have C.N. = 6 because it can use it's 3s, 3p and 3d orbitals for co-ordinate bond formation.

57) **Question Explanation:** Identifying a reaction where at least one product is insoluble.

Concept: Solubility Rules and Precipitation Reactions.

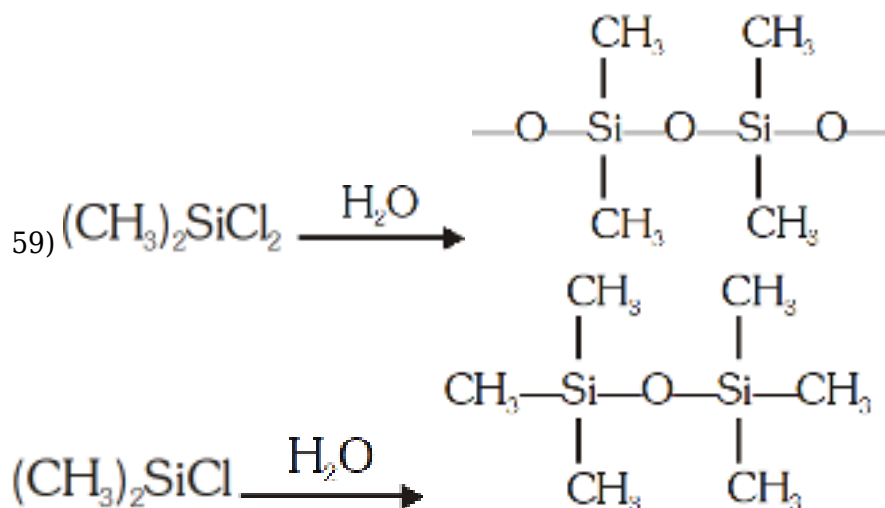


$\text{Cr}_2\text{O}_7^{2-}$ and SO_4^{2-} are generally soluble.



Final Answer: 1.

58)



60) **Solution:**

As the atomic number increases across the lanthanide series, the atomic and ionic radii generally decrease due to poor shielding by 4f electrons, a phenomenon known as lanthanide contraction. However, Europium (Eu) has an exceptionally large atomic radius due to its stable half-filled f-orbital configuration, which leads to weak metallic bonding.

General trend: $\text{Ce} > \text{Gd} > \text{Lu}$.

Due to its $4f^7$ configuration, Eu has an unusually large size.

The correct order is $\text{Eu} > \text{Ce} > \text{Gd} > \text{Lu}$.

ENGLISH PROFICIENCY

61) The correct answer is (2)

62) The correct answer is (1)

63) The correct answer is (3)

64) The correct answer is (2)

65) The correct answer is (3)

66) The correct answer is (1)

67) The correct answer is (3)

68) The correct answer is (2)

69) The correct answer is (2)

70) The correct answer is (2)

LOGICAL REASONING

71) The correct answer is (1)

72) The correct answer is (3)

73) The correct answer is (2)

74) The correct answer is (4)

75) The correct answer is (4)

76) The correct answer is (4)

77) The correct answer is (4)

78) The correct answer is (2)

79) The correct answer is (4)

80) The correct answer is (3)

81) The correct answer is (1)

82) The correct answer is (3)

83) The correct answer is (4)

84) The correct answer is (3)

85) The correct answer is (2)

86) The correct answer is (3)

87) The correct answer is (3)

88) The correct answer is (2)

89) The correct answer is (3)

90) The correct answer is (2)

MATHEMATICS

$$\begin{aligned}
 \text{Sol. } S_n &= \frac{1}{2} + \frac{1}{6} + \frac{1}{12} + \frac{1}{20} \dots \text{N terms} \\
 S_{2025} &= \sum_{n=1}^{2025} \frac{1}{n(n+1)} = \sum_{n=1}^{2025} \left(\frac{1}{n} - \frac{1}{n+1} \right) \\
 &= \left(\frac{1}{1} - \frac{1}{2} \right) + \left(\frac{1}{2} - \frac{1}{3} \right) + \dots + \left(\frac{1}{2025} - \frac{1}{2026} \right) \\
 &= \frac{2025}{2026} \\
 \sqrt{2026 \cdot S_{2025}} &= \sqrt{2025} = 45 \\
 \text{Given : } \frac{6}{2} | 2p + (6-1)p | - 45 \\
 9p &= 45 \\
 p &= 5 \\
 |A_{20} - A_{15}| &= |5 + 19 \times 5| - |5 + 14 \times 5| \\
 &= |90 - 65| \\
 &= 25
 \end{aligned}$$

91)

92) common normal to $y^2 = 8x$ and $x + y + 4 = 0$ meets parabola at P and straight line at Q, so required distance = 2PQ

93) Equation of parabola can be written as

$$(y-1)^2 = -\frac{3}{2} \left(x - \frac{11}{6} \right)$$

Equation of tangent at vertex is $x - \frac{11}{6} = 0$

$$94) q(-1) = 0$$

$$-k + k^2 - k^3 + 1 = 0$$

$$k(k-1) - 1(k-1)(k^2 + k + 1) = 0$$

$$(k-1)(-k^2 - 1) = 0$$

$$k = 1$$

$$\square \quad q(x) = x^3 + x^2 + x + 1 = (x^2 + 1)(x + 1)$$

$$\square \quad p(x) = x^2 + 1$$

95) Let $x = \tan^2 \alpha$, $y = \tan^2 \beta$

$$\square \frac{\sec^4 \alpha}{\tan^2 \beta} + \frac{\sec^4 \beta}{\tan^2 \alpha} = \frac{(1+x)^2}{y} + \frac{(1+y)^2}{x}, x, y > 0$$

$$= \left(\frac{1}{y} + 2\frac{x}{y} + \frac{x^2}{y} \right) + \left(\frac{1}{x} + \frac{2y}{x} + \frac{y^2}{x} \right)$$

$$= \left(\frac{x^2}{y} + \frac{1}{y} + \frac{y^2}{x} + \frac{1}{x} \right) + 2 \left(\frac{x}{y} + \frac{y}{x} \right)$$

96) $2^0, (2^1, 2^1) (2^2, 2^2, 2^2, 2^2) \dots (2^k, 2^k, \dots, 2^k)$
 (2 time) (2² times) (2^k times)

2^k starts with $2^{k \text{th}}$ term and end with $(2^{k+1} - 1)^{\text{th}}$

2^{10} starts with 1024^{th} terms and ends with 2047^{th} terms

97)

The plane is

$$(x + 3y + z) + \lambda(2x - y) = 4$$

$$(x + 3y + z - 4) + \lambda(2x - y) = 0$$

This plane always pass through the line of intersection of the planes

$$x + 3y + z - 4 = 0$$

$$2x - y = 0 \Rightarrow \frac{x}{1} = \frac{y}{2} \dots (i)$$

$$\text{Now } x + 3y + z - 4 = 0 \Rightarrow 7x + z - 4 = 0$$

$$\frac{x}{1} = \frac{z-4}{-7} \dots (ii)$$

Plane passes through the line

$$\frac{x}{1} = \frac{y}{2} = \frac{z-4}{-7}$$

98)

The sum of the coefficients which doesn't contain b is (put $a = c = d = 1$ and $b = 0$) = 3^6

The sum of the coefficients which doesn't contains a and b is (put $a = 0$, $b = 0$ and $c = d = 1$) = 2^6

Sum of the coefficients which contain a but not b is = $3^6 - 2^6$

99) Tangent of $xy = c^2$ at $\left(ct, \frac{c}{t}\right)$ is

$$\left(\frac{x \cdot c}{t} + yct \right) = 2c^2$$

$$\Rightarrow x + yt^2 = 2ct \dots (1)$$

Slope of tangent = $-\frac{1}{t^2}$

Equation of line passing (0,0) and perpendicular to tangent is $y = t^2 x \Rightarrow t^2 = \frac{y}{x}$

Now squaring (1), $(x + yt^2)^2 = 4c^2t^2$

for locus of foot of perpendicular replace $t^2 = \frac{y}{x}$

Locus is $\left(x + y \left(\frac{y}{x}\right)\right)^2 = 4c^2 \left(\frac{y}{x}\right)$

$$\Rightarrow (x^2 + y^2)^2 = 4c^2yx$$

100)

$$s = \frac{6^r}{2^{2r+1} + 3^{2r+1}} = \frac{\frac{6^r}{2^{2r+1}}}{1 + \left(\frac{3}{2}\right)^{2r+1}} = \frac{\frac{2^r \cdot 3^r}{2 \cdot 2^{2r}}}{1 + \left(\frac{3}{2}\right)^{r+1} \left(\frac{3}{2}\right)^r},$$

Here

$$= \frac{\frac{1}{2} \left(\frac{3}{2}\right)^r}{1 + \left(\frac{3}{2}\right)^{r+1} \left(\frac{3}{2}\right)^r} = \frac{\left(\frac{3}{2}\right)^r \left(\frac{3}{2} - 1\right)}{1 + \left(\frac{3}{2}\right)^{r+1} \left(\frac{3}{2}\right)^r}$$

$$= \frac{\left(\frac{3}{2}\right)^{r+1} - \left(\frac{3}{2}\right)^r}{1 + \left(\frac{3}{2}\right)^{r+1} \left(\frac{3}{2}\right)^r}$$

$$\text{Now } \sum_{r=1}^{\infty} \tan^{-1} \left(\frac{6^r}{2^{2r+1} + 3^{2r+1}} \right)$$

$$= \sum_{r=1}^{\infty} \tan^{-1} \left(\frac{\left(\frac{3}{2}\right)^{r+1} - \left(\frac{3}{2}\right)^r}{1 + \left(\frac{3}{2}\right)^{r+1} \left(\frac{3}{2}\right)^r} \right)$$

$$= \sum_{r=1}^{\infty} \tan^{-1} \left(\frac{3}{2}\right)^{r+1} - \tan^{-1} \left(\frac{3}{2}\right)^r$$

$$= \lim_{n \rightarrow \infty} \sum_{r=1}^n \tan^{-1} \left(\frac{3}{2}\right)^{r+1} - \tan^{-1} \left(\frac{3}{2}\right)^r$$

$$= \lim_{n \rightarrow \infty} \left(\tan^{-1} \left(\frac{3}{2}\right)^2 - \tan^{-1} \left(\frac{3}{2}\right) \right) + \left(\tan^{-1} \left(\frac{3}{2}\right)^3 - \tan^{-1} \left(\frac{3}{2}\right)^2 \right) \dots$$

$$\dots \left(\tan^{-1} \left(\frac{3}{2}\right)^{n+1} - \tan^{-1} \left(\frac{3}{2}\right)^n \right)$$

$$= \lim_{n \rightarrow \infty} \tan^{-1} \left(\frac{3}{2}\right)^{n+1} - \tan^{-1} \frac{3}{2} = \frac{\pi}{2} - \tan^{-1} \frac{3}{2} = \cot^{-1} \frac{3}{2}$$

101)

Total number of ways to choose 4 numbers out of 12 is ${}^{12}C_4$

Let E denote the event minimum is 5 and F denote the event that maximum is 10 ..

$$\text{Then } P\left(\frac{E}{F}\right) = \frac{P(E \cap F)}{P(F)} ; \text{ But } P(F) = \frac{{}^9C_3}{{}^{12}C_4}$$

$$\text{and } P(E \cap F) = \frac{{}^4C_2}{{}^{12}C_4}$$

$$P\left(\frac{E}{F}\right) = \frac{\frac{{}^4C_2}{{}^{12}C_4}}{\frac{{}^9C_3}{{}^{12}C_4}} = \frac{{}^4C_2}{{}^9C_3}$$

□

$$\frac{\frac{4.3}{2}}{\frac{9.8.7}{3.2}} = \frac{6}{84} = \frac{1}{14}$$

$$102) \quad I = \int_{1/e}^{\tan x} \frac{t}{1+t^2} dt + \int_{1/e}^{\cot x} \frac{1}{t(1+t^2)} dt$$

put $t = \frac{1}{x}$

$$I = \int_{1/e}^{\tan x} \frac{t}{1+t^2} dt + \int_e^{\tan x} \frac{1}{\frac{1}{x} \left(1 + \frac{1}{x^2}\right)} \cdot \frac{-1}{x^2} dx$$

$$I = \int_{1/e}^{\tan x} \frac{t}{1+t^2} dt + \int_{\tan x}^e \frac{x}{1+x^2} dx = \int_{1/e}^e \frac{t}{1+t^2} dt = \left(\frac{1}{2} \ln(1+t^2) \right)_{1/e}^e = 1$$

$$103) \text{ put } \frac{n}{3} = k$$

$$L = \lim_{k \rightarrow \infty} \left(\frac{(k+1)(k+2)\dots(3k)}{k^{2k}} \right)^{1/k}$$

⇒ taking log

$$\ln L = \lim_{k \rightarrow \infty} \frac{1}{k} \left[\ln \left(1 + \frac{1}{k} \right) + \ln \left(1 + \frac{2}{k} \right) + \dots + \ln \left(1 + \frac{2k}{k} \right) \right]$$

$$= \lim_{k \rightarrow \infty} \frac{1}{k} \sum_{r=1}^{2k} \left(\ln \left(1 + \frac{r}{k} \right) \right)$$

$$= \int_0^2 \ln(1+x) \Rightarrow \left(x \ln(1+x) - \int \frac{x}{x+1} dx \right)_0^2$$

$$= [x \ln(1+x) - x + \ln(1+x)]_0^2$$

$$\ln L = (2 \ln 3 - 2 + \ln 3) = 3 \ln 3 - 2$$

$$L = e^{3 \ln 3 - 2} = \frac{27}{e^2}$$

$$104) \quad \lim_{x \rightarrow 0} \frac{7 \left[\left(1 + \frac{x}{2401} \right)^{1/4} - 1 \right]}{49 \left(1 - \left(1 + \frac{x}{2401} \right)^{1/2} \right)}$$

$$= \frac{-1}{7} \cdot \frac{1}{4} \cdot \frac{1}{1/2}$$

$$= \frac{-1}{14}$$

105) Let $2^{32} = n$

$$\begin{aligned} k &= \lim_{x \rightarrow 1} \frac{x^n - nx + n - 1}{(x-1)^2} - \lim_{x \rightarrow 1} \frac{x^n - 1 - n(x-1)}{(x-1)^2} \\ &= \lim_{x \rightarrow 1} \frac{(x^{n-1} + x^{n-2} + \dots + 1) - n}{x-1} \\ &= (n-1) + (n-2) + \dots + 1 = \frac{2^{32}(2^{32}-1)}{2} \\ &= 2^{63} - 2^{31} \end{aligned}$$

106) $r = \sqrt{2 \times 8}$

107) **Question Explanation:**

Finding common elements in cartesian products.

Concept: Cartesian product interaction

Solution:

If sets A and B have n elements in common, the the interaction of the cartesian products $(A \times B) \cap (B \times A)$ contains n^2 elements.

Calculation: Elements in common (n) = 4

Number of elements in intersection = $n^2 = 4^2 = 16$

Final answer: Option (3)

108) $f(x) = x^3 - 6x^2 + ax + b$

applying $f(1) = f(3) \Rightarrow a = 11$

109) $A = \frac{\sqrt{3}}{4} a^2$

$$\frac{dA}{dt} = \frac{\sqrt{3}}{4} 2a \frac{da}{dt}$$

$$\Rightarrow 12 = \frac{\sqrt{3}}{4} 2a \sqrt{3} \Rightarrow a = 8$$

110) Let $x < 3$

$$\Rightarrow x^2 2^{x+1} + 2^{5-x} = x^2 2^{7-x} + 2^{x-1}$$

$$\Rightarrow 2^{x+1} (4x^2 - 1) = 2^{5-x} (4x^2 - 1)$$

$$\Rightarrow x = \pm \frac{1}{2}$$

Number of solution in $(-2, 2)$ are 2.

111)

For option (A),

$$e^x - \int_0^x f(t) \sin t dt > 0, \forall x \in (0, 1)$$

For option (B)

$$1 + x^{2021} - (f(x))^{2022} > 0, \forall x \in (0, 1)$$

For option (C), let

$$f(x) + \int_0^{\frac{\pi}{2}} f(t) \cdot \sin t dt > 0, \forall x \in (0, 1)$$

For option (D),

$$g(x) = 1 - x^{2021} - (f(x))^{2022}$$

$$g(1) < 0$$

$$g(0) > 0$$

$\Rightarrow g(x) = 0$ has at least one solution in $(0, 1)$

112)

$$15 < x_1 + x_2 + x_3 \leq 20$$

$$\Rightarrow x_1 + x_2 + x_3 = 16 + r, r = 0, 1, 2, 3, 4$$

Now, the number of positive integral solutions of $x_1 + x_2 + x_3 = 16 + r$ is ${}^{13+r+3-1}C_{13+r}$, i.e., ${}^{15+r}C_{13+r} = {}^{15+r}C_2$.

Thus, the total number of solutions is

$$\begin{aligned} \sum_{r=0}^4 {}^{15+r}C_2 &= {}^{15}C_2 + {}^{16}C_2 + {}^{17}C_2 + {}^{18}C_2 + {}^{19}C_2 \\ &= \frac{1}{2}(15 \times 14 + 16 \times 15 + 17 \times 16 + 18 \times 17 + 19 \times 18) \\ &= 685 \end{aligned}$$

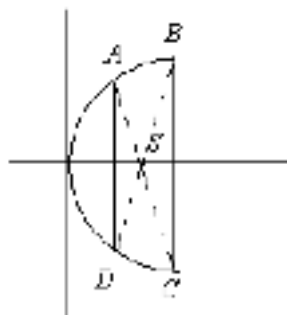
Focus $S = (1, 0)$

113) $As = 1+t^2 = x$ (say)

And $\frac{1}{x} + \frac{1}{\frac{25}{4} - x} = 1$

$x = 5/4, 5$

$t = -\frac{1}{2}, \pm 2$

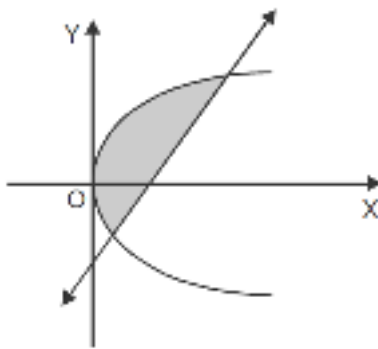


114)

$$\tan^{-1} \frac{2 \cos x}{1 - \cos^2 x} = \tan^{-1} \left(\frac{1}{\sin^2 x} \right)$$

$$\begin{aligned}\frac{2\cos x}{\sin^2 x} &= \frac{1}{\sin^2 x} \\ \Rightarrow 2\cos x &= 1 \\ \Rightarrow x &= \frac{\pi}{3}\end{aligned}$$

$$\begin{aligned}115) \quad r^2 &= \left(x_1 - \frac{y_1}{m_1}\right)^2 \left(\frac{5}{4}\right) = \frac{\left(x_1 + \frac{y_1}{m_1}\right)^2}{4} + \left(x_1 - \frac{y_1}{m_1} - y_1\right)^2 \\ \Rightarrow y^2 + \frac{dy}{m} + \frac{2y^2}{m} - 2xy &= 0 \\ -y^2 + 2xy &= \frac{y}{m}(x + 2y) \\ m &= \frac{x + 2y}{2x - y} \\ \frac{dy}{dx} &= \frac{x + 2y}{2x - y}\end{aligned}$$



116)

$$\text{We have : } y^2 \leq 2x \quad \dots(1)$$

$$\text{and } y \geq 4x - 1 \quad \dots(2)$$

$$\text{Solving, } y^2 = 2x \text{ and } y = 4x - 1,$$

$$\text{we get } y = 1, -\frac{1}{2}.$$

$$= \int_{-1/2}^1 \left[\frac{y+1}{4} - \left(\frac{y^2}{2} \right) \right] dy$$

$\therefore$ Reqd. area

$$\begin{aligned}&= \left[\frac{y^2}{8} + \frac{y}{4} - \frac{y^3}{6} \right]_{-1/2}^1 \\&= \left(\frac{1}{8} + \frac{1}{4} - \frac{1}{6} \right) - \left(\frac{1}{32} - \frac{1}{8} + \frac{1}{48} \right) \\&= \frac{3+6-4}{24} - \frac{3-12+2}{96} \\&= \frac{5}{24} + \frac{7}{96} \\&= \frac{20+7}{96} = \frac{27}{96} = \frac{9}{32}\end{aligned}$$

$$117) \frac{dy}{dx} = 2(x-1) \sin x + (x^2 - 2x) \cos x$$

Now both side integrate

$$y(x) = \int 2(x-1) \sin x \, dx + \left[(x^2 - 2x) (\sin x) - \int (2x - 2) \sin x \, dx \right]$$

$$y(x) = (x^2 - 2x) \sin x + \lambda$$

$$y(0) = 0 + \lambda \Rightarrow 2 = \lambda$$

$$y(x) = (x^2 - 2x) \sin x + 2$$

$$y(2) = 2$$

118)

$$\Rightarrow \log_2(x^2 - x) \cdot \log_2\left(\frac{x-1}{x}\right) + (\log_2 x)^2 = 4$$

$$\Rightarrow (\log_2 x + \log_2(x-1))(\log_2(x-1) - \log_2 x) + (\log_2 x)^2 = 4$$

$$\Rightarrow (\log_2(x-1))^2 - (\log_2 x)^2 + (\log_2 x)^2 = 4$$

$$(\log_2(x-1))^2 = 4$$

$$\log_2(x-1) = 2, -2$$

$$x-1 = 2^2, \frac{1}{4}$$

$$x = 5, \frac{5}{4}$$

119) **Explain Question:**

Find the value of λ if given system of equations has non-trivial solution.

Concept:

Use Cramer's rule & cube root of unity.

$$\text{Solution: } \begin{vmatrix} 1 & \lambda & \lambda^2 \\ \lambda^2 & 1 & \lambda \\ \lambda & \lambda^2 & 1 \end{vmatrix} = 0$$

Expand the determinant:

$$1(1 - \lambda^3) - \lambda(\lambda^2 - \lambda^2) + \lambda^2(\lambda^4 - \lambda) = 0$$

$$\Rightarrow 1 - \lambda^3 - 0 + \lambda^6 - \lambda^3 = 0$$

$$\Rightarrow \lambda^6 - 2\lambda^3 + 1 = 0$$

$$\Rightarrow (\lambda^3 - 1)^2 = 0$$

$$\Rightarrow \lambda^3 = 1$$

$$\Rightarrow \lambda = 1, \omega, \omega^2$$

Final Answer: Option(4)

$$120) k(x-7)(x-13) + (x-10)(x-4) = 0$$

121)

$$|Z_1| = 1, |Z_2| = 1$$

$$Z_1^2 + Z_2^2 = 5$$

$$\begin{aligned} \text{so } \bar{Z}_1^2 + \bar{Z}_2^2 &= 5 \\ (Z_1 - \bar{Z}_1)^2 + (Z_2 - \bar{Z}_2)^2 \\ &= Z_1^2 + Z_2^2 + \bar{Z}_1^2 + \bar{Z}_2^2 - 2|Z_1|^2 - 2|Z_2|^2 \end{aligned}$$

$$10 - 4 = 6$$

$$\begin{aligned} 122) & \frac{n}{3} \left[x - \frac{(n+1)}{1} \right] \left[\frac{x}{2} - \frac{(n+1)}{2} \right] \\ & \left[\frac{x}{3} - \frac{(n+1)}{3} \right] \dots \left[\frac{x}{n} - \frac{(n+1)}{n} \right] = [x - (n+1)]^n \text{ Coefficient of } x^{n-6} \text{ is } {}^nC_6(n+1)^6 \end{aligned}$$

$$123) |A - \lambda I| = 0$$

124) Given set $A = \{1, 2, 3, \dots, 9\}$

Let $(x, y) \in A \times A$ which is related to $(2, 5)$

by given relation.

$(x, y) R (2, 5)$

$$\Rightarrow x + 5 = y + 2$$

$$\Rightarrow 1 + 5 = 4 + 2, 2 + 5 = 5 + 2, 3 + 5 = 6 + 2, \dots$$

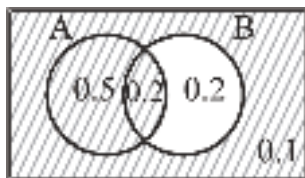
Hence equivalence class of $[(2, 5)]$

$$= \{(1, 4), (2, 5), (3, 6), (4, 7), (5, 8), (6, 9)\}.$$

125)

Consider $\sim [p \rightarrow (\sim p \vee q)] \equiv p \wedge \sim (\sim p \vee q)$

$$\equiv p \wedge (p \wedge \sim q) \equiv p \wedge p \wedge \sim q \equiv p \wedge \sim q$$



126)

$P(A \cup B^c) = \text{Total case}$

$= \text{shaded region}$

$$\text{So, } P\left(\frac{B}{A \cup B^c}\right) = \frac{0.2}{0.8} = \frac{1}{4}$$

$$127) \vec{R} \times \vec{B} = \vec{C} \times \vec{B}$$

$$\vec{A} \times (\vec{R} \times \vec{B}) = \vec{A} \times (\vec{C} \times \vec{B})$$

$$\Rightarrow (\vec{A} \cdot \vec{B})\vec{R} - (\vec{A} \cdot \vec{R})\vec{B} = (\vec{A} \cdot \vec{B})\vec{C} - (\vec{A} \cdot \vec{C})\vec{B}$$

$$\Rightarrow (-38)\vec{R} - \vec{O} = (-38)\vec{C} - 19\vec{B}$$

$$\Rightarrow \frac{|\vec{B}|}{|\vec{R} - \vec{C}|} = 2$$

128) Projection of line $\frac{x}{2} = \frac{y-1}{2} = \frac{z-1}{1}$ on a plane P is $\frac{x}{1} = \frac{y-1}{1} = \frac{z-1}{-1}$.

□ Plane through these lines is perpendicular to the plane P.

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 2 & 1 \\ 1 & 1 & -1 \end{vmatrix} = -3\hat{i} + 3\hat{j}$$

Normal to the plane determined by the given lines is

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -3 & 3 & 0 \\ 1 & 1 & -1 \end{vmatrix} = -3\hat{i} - 3\hat{j} - 6\hat{k}$$

□ Direction ratios normal to the required plane is

□ Equation of the plane is $x + y + 2z - 3 = 0$ as it passes through (0, 1, 1).

Its distance from origin is $\sqrt{\frac{3}{2}}$.

129) For the line to be co-planar

$$\begin{vmatrix} 2 & 0 & k \\ 1 & k & -2 \\ 4 & 1 & -1-k \end{vmatrix} = 0$$

$$\Rightarrow 2(-k - k^2 + 2) + k(1 - 4k) = 0$$

$$-2k - 2k^2 + 4 + k - 4k^2 = 0$$

$$-6k^2 - k + 4 = 0$$

$$6k^2 + k - 4 = 0$$

This equation has two distinct roots So two such planes exist.

130) Sum of 100 items = $45 \times 100 = 4500$,

sum of correct obs. = $19 + 31 = 50$,

sum of incorrect obser. = $91 + 13 = 104$

corrected sum = $4500 - 104 + 50 = 4446$

□ corrected mean = $\frac{4446}{100} = 44.46$